Knowledge.

With which is incorporated Hardwicke's Science Gossip and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

JULY, 1910.

ARRHENIUS' VIEWS CONCERNING THE PLANETARY ATMOSPHERES.

By THE RT. HON. SIR HENRY ROSCOE, F.R.S.

THE question of life on the planets is one which has interested mankind from the earliest times, and has been the subject of discussion both by numerous philosophers and novelists. Amongst all the planets, Mars is the one of whose surface we have the most detailed knowledge, and the pages of this journal have been enriched by many communications describing the extraordinary appearances on the surface of this planet which have been investigated by many astronomers, but more especially by Professor Percival Lowell.

Quite recently an interesting memoir on the more general question of the atmospheres of the planets has appeared in Ostwald's "Annalen der Naturphilosophie" by Professor Svante Arrhenius, of Stockholm, a man who is honoured by all interested in Science as the most luminous and far-sighted writer on questions of cosmogony. For, if we cannot accept all Arrhenius' ideas, and if his conclusions do not all bring conviction to the mind of some of us, they have this most valuable quality that they raise engrossing topics in a striking manner, and "give us to think." It may, therefore, interest the readers of "KNOWLEDGE" if I not only try to give them a short epitome of Arrhenius' views, on the question of the existence of atmospheres on the planets, but, state the scientific evidence which he brings forward to show that fundamental changes have gone on in past ages, and are still going on, in the chemical composition of these atmospheres.

By the term atmosphere is meant the gaseous envelope surrounding a solidified or liquid nucleus, so that, omitting the cases of liquid nuclei, the enquiry is limited to the four inner planets, Mercury, Venus, the Earth and Mars. It is true that the minor planets whose orbits lie between Mars and Jupiter have also probably hard crusts, but they are so small—no larger than our moon—that, as will be shown hereafter, the probability is that they, like our satellite, are not endowed with an atmosphere.

Coming to the consideration of the four inner planets, Arrhenius concludes that Mercury is to be placed in the same category as our moon. It possesses, like the moon, a feeble power of reflecting light, the albedo of these two being from 0·13 to 0·14, whilst that of Mars is 0·22, and of Venus 0·76. Hence it would appear that the atmosphere of Venus is very similar to that of the Earth. The density of the atmosphere of Mars is shown by its feeble albedo to be but small. Professor Lowell concludes that each cubic metre of the atmosphere of Mars weighs only 22% of the same bulk of terrestrial atmosphere.

The explanation of the absence of atmosphere from the moon has long been given. Ritter concludes that owing to the rate of the molecular motion of hydrogen the moon has been unable to retain this gas in its atmosphere; and the same indeed may be said of the other less dense gases. Johnstone Stoney has pointed out that the amount of gases retained on the surface of the planets diminishes with gravity, and for this reason we must assume that the minor planets, which are no larger than our moon, are also without an atmosphere.

With regard to Mercury, the force of gravity on its surface is not quite half as much again as on the surface of the moon, and, therefore, in all probability it is in the same position as the moon with regard to its power of retaining gaseous material. There is, however, another point to consider. On satisfactory grounds it is probable that Mercury always turns the same side to the sun; hence the temperature of the dark side of this planet which radiates into space, does not, in all probability, rise more than 50° above the absolute zero. All gases, with the exception of helium and hydrogen, must, therefore, condense to a large solid mass. But helium and hydrogen possess so small a density that, according to Stoney's hypothesis, they must long ago have disappeared from the atmosphere of Mercury. Hence the atmosphere of Mercury can contain neither light nor heavy gases, for the first have disappeared, and the second must be condensed. A similar argument applies to the moon, whose dark side—night lasting for a fortnight—has time to reach a temperature close upon that of space.

XUM

It might be assumed that if this condition exists on the moon it might be possible to see traces of the condensed gases in the form of hoar-frost on some of the lunar craters when they first appear in sunlight. Indeed, statements to this effect have been made, although these are somewhat doubtful. At any rate, no visible quantity of vapour exists on the moon's surface.

If it is true—as many observers state—that Venus also turns one side only to the sun, we might assume that the conditions of this planet are the same as on Mercury, that is, it could not possess any recognisable atmosphere. On the other hand, it is a matter of general agreement that Venus does possess a dense atmosphere, the refraction being so great that the horns appear normally less than 180° apart.

According to Stoney the small amount of helium found in the terrestrial atmosphere, in spite of the regular addition of this gas from deep-seated springs, shows that the amount of this gas in the atmosphere is diminishing, and we must therefore assume that the same state of things occurs on Venus, especially as the force of gravity there is only one-fifth that on the Earth's surface. Hence helium, and probably also hydrogen, cannot occur in any large amount in the atmosphere of Venus, whilst the other more easily condensible gases would remain as solids on the dark side of the planet. As, however, it is certain that an atmosphere does exist on Venus, Arrhenius concludes that the planet does rotate, and that its period of rotation is a short one—say, twenty-four hours.

In the case of Mars we know by direct observation that a white solid deposit (snow ?) exists at each pole, varying in extent with the seasons, and such a condition can only exist in presence of an atmosphere. Besides, clouds and fog have been observed in the atmosphere of the planet, and sand storms on its surface have also been noticed.

This much we know with a great degree of certainty of the atmospheres of the planets of our solar system. There are doubtless many other planets possessing atmospheres in the neighbourhood of other suns, although our knowledge of these is nil, for the so-called dark companions of certain stars are of such large dimensions that we must assume that they consist of gaseous material.

Arrhenius next proceeds to discuss the even more interesting question of the changes in chemical composition which, in his view, our own atmosphere has undergone, and is still undergoing. First, as regards the chemical composition of the solid portion of the heavenly bodies, a knowledge of which has been obtained by the analysis of Meteorites—we are justified in assuming that the outer portions of their solidified crust consists, like the earth's surface, of a mixture of silicates. This conclusion is also borne out by the low specific gravity, 3·34, of the moon, whilst that of Mars is 4·03, and of Venus 3·58, that of the Earth being 5·53. This indicates that whilst the moon probably consists entirely of silicates, and Mars chiefly, Venus, like the Earth, consists half of silicates and half of metallic nuclei.

As regards our own atmosphere, weighty considerations bring Arrhenius to the conclusion that in past ages it has undergone deep-seated alterations, and that these still continue.

On the cooling of the magma a solid surface forms, and it is only from that point onwards that a special atmosphere can be said to exist. For then gases make their appearance from the inner portions of the planet. These chiefly consist of hydrogen and carbonic acid gas, and these rise to the higher parts of the atmosphere, above the clouds, and the absorbing media present in the lower portions. And in these higher regions the sunlight gives rise to photo-chemical reactions, ordinary chemical reactions proceeding only slowly, owing to the low temperature existing in the upper regions. By degrees free oxygen and carbon make their appearance through the catalytic action of chlorophyl. The powerfully reducing gases of the original atmosphere, such as hydrogen and gaseous hydro-carbons which exist in the higher portions of the atmosphere, are gradually burnt by the oxygen, so that at last, together with oxygen, it is only the chemically inert gases—such as nitrogen—which remain as the main constituents of the atmosphere. The two gases which, together with oxygen, control life, namely aqueous vapour and carbonic acid, rise into the atmosphere from rents in the solid crust of the Earth. Without doubt under these conditions life develops on the surface of the planet. This is the condition which the Earth at present occupies, and probably also that of Venus, whose development in consequence of its higher temperature—a mean of about 65° Centigrade—is not so advanced as that of the Earth. Gradually the crust thickens. Aqueous vapour begins to condense to form the ocean. Gradually carbonic acid gas and water disappear from the atmosphere and are deposited in the form of calcium carbonate by infusorial action. At the same time sand and clay are washed into the sea and form gigantic masses of sedimentary rock. A gradual diminution of volcanic action takes place. The supply of water and carbonic acid gas is lessened, and therefore their existence in the atmosphere becomes a constantly diminishing quantity. And when this diminution reaches a certain point the surface of the planet becomes a desert. Mars at the present time has reached this point. Plant growth diminishes. No oxygen is produced. That existing in the atmosphere combines partly with nitrogen to form nitrates, and partly oxidizes iron to form iron compounds, and, like nitrogen, gradually will disappear. In consequence of the want of water the circle of life gradually ceases. The atmosphere constantly becomes less dense, the difference of temperature between day and night, summer and winter, becomes greater, and the remaining gases disappear owing to their molecular motion. This is the condition of the moon, also probably of Mercury and of the minor planets, as well as of most of the moons of other planets. The solid mass of the heavenly bodies is from this point forward a dead and unalterable one.

XUM

THE GROWTH OF A CENTIPEDE.

LITHOBIUS FORFICATUS L.

By CHARLES SILLEM, F.L.S.

With Illustrations drawn from Nature by the Writer.

FOR some little time I have been working in connection with the forthcoming monograph on British centipedes and millipedes, which is to be published by the Ray Society. As this has necessitated the keeping of centipedes in confinement, I have had an opportunity of carefully watching their habits, and the following account of the growth and development of the young of the common species (*Lithobius forficatus* L.) after they leave the egg may be of some interest.

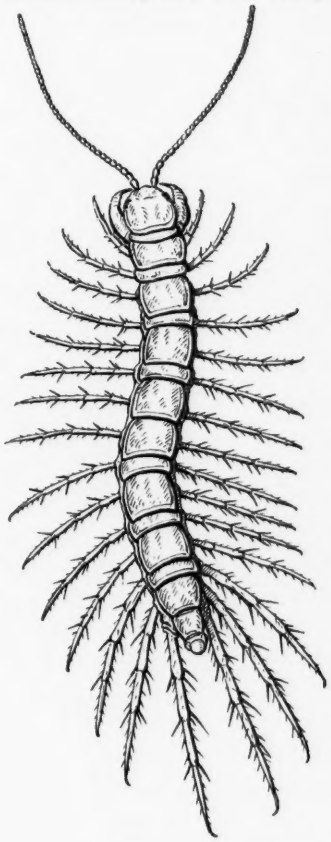


FIGURE 1.
An adult female of *Lithobius forficatus*.

The adult animals were kept in large glass dishes with a layer of earth at the bottom, on which were scattered pieces of decayed wood and bark; the earth was constantly kept damp, and the animals were fed on small worms with, occasionally, some raw meat.

It may be added that the animals appeared to keep in the best of health and condition: deaths were few, and many specimens are alive and well after being kept in confinement for more than two years.

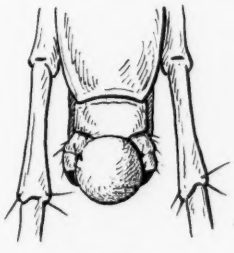


FIGURE 3.
An egg in position between the two hooks.

The common centipede (*Lithobius forficatus*) is probably known to everyone. It is found under stones and pieces of wood, or buried in the earth. It is nocturnal in its habits, keeping under ground or hidden in the day time. This fact adds considerably to the difficulty of making any observations on its habits. If during the day one looks into the glasses to which have been mentioned, no signs of life are to be seen, but if after dark a light is suddenly struck, all the animals will be found actively moving about and feeding, though they soon disappear and give no opportunity for prolonged observation.

FIGURE 2.
The end of the body of a female *Lithobius forficatus* showing the two hooks with which the egg is carried.

The female *Lithobius forficatus*, (see Figure 1) has, at the end of the body, two small hooks, (see Figure 2). The latter are not always visible, as the animal seems to be able to withdraw them till they are covered by the last segment of the body, but they are frequently to be seen, especially when the animal is excited and moving about. When the egg is laid, it is seized by these hooks and carried about (in the manner shown in Figure 3) till a suitable place for depositing it is found. I have frequently watched a female carrying her egg for some hours, but if she was touched or an attempt was made to catch her, she immediately dropped it.

It is stated in *The Cambridge Natural History* (Volume V., Page 39) that the female "uses her hooks to roll the egg round and round until it is completely covered by earth." I was never fortunate enough to observe this process, and all the eggs found were simply deposited on the earth without any apparent attempt at concealment, but no doubt some eggs were concealed

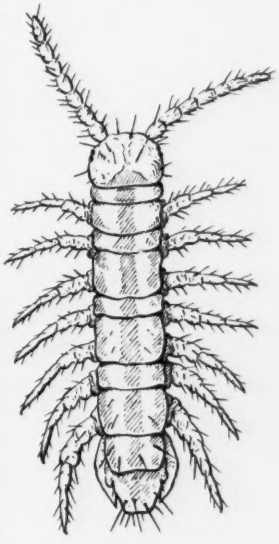


FIGURE 4.
A newly-hatched *Lithobius forficatus*.

XUM

in the way mentioned above, for although I used to search carefully every day for eggs, and remove them at once, occasionally a newly-born young one was found which no doubt had been hatched from a hidden egg.

The egg is spherical in shape; of clear, slightly creamy white colour, and about one millimetre in diameter. It seems that the great majority of the eggs are laid in the Spring, only occasionally was one found so late as July or August. Eggs were laid in February by some of the specimens which were kept in captivity, but the animals had lived in a warm room all the Winter, and it is doubtful whether in a state of nature they would begin to lay so early as this. As soon as I discovered an egg, it was carefully placed on a piece of damp blotting paper in a small glass, over which a cover was put so that the egg might constantly be in a moist atmosphere. I found that the shortest time, that elapsed before an egg hatched was two weeks and the longest, four weeks.

FIGURE 5.
The end of the body of a young *Lithobius forficatus*, about thirty-six hours old.

The freshly-hatched centipede (see Figure 4) is a very different looking creature from the adult. It is about two millimetres in length, and in colour, instead of being the rich chestnut of the full-grown animal, is almost pure white—some few specimens were a pale mauve. In place of the fifteen pairs of legs of the adult, it has only seven functional pairs; the eighth pair is present, but not fully developed, and in some specimens the ninth pair showed as a small outgrowth. There are no evident signs of the large poison claws (maxillipedes) which are so marked a feature of the full-grown centipede, and in place of the thirty-nine or more joints to the antenna, which are found in the adult, the young animal has only seven. It is a lively, active little creature and runs about quite freely and swiftly when it is only a few hours old.

FIGURE 6.
The development of the ninth and tenth pairs of legs.

In the large number of specimens examined, I found that the order in which the legs became functional, never varied, but that the time which elapsed between the development of the different pairs did considerably.

Figure 5 shows the appearance of the eighth and ninth pairs about thirty-six hours after hatching. The eighth pair of legs is fully developed and used, on the third day:—this happened in the case of all the specimens observed.

The ninth and tenth pairs (see Figure 6) appear to come to perfection together from eighteen to twenty days after the eighth pair.

From thirteen to twenty days may now elapse before the eleventh and twelfth pairs are produced, and then, after from nineteen to twenty-six days, the last three pairs, namely the thirteenth, fourteenth, and fifteenth grow and come into use at the same time (see Figure 7).

In giving the number of days in the different cases, the shortest and longest periods which were observed in different specimens, have been taken. As regards the order of development of the legs, it would be interesting to know whether it is constant in the *Lithobiidae: in all my specimens of *Lithobius forficatus*, I never found any deviation from that given.

As the young one grows, it gradually darkens in tone and turns to the chestnut colour of the adult.

When the fifteenth pair of legs is developed and the animal is from fifty-three to seventy-seven days old, it is about a quarter of the length of the average adult. It grows very little if at all in the winter, and specimens when two years old are little more than half the size of the full-grown animal. Finally, although I have not yet been able to verify the fact, I believe that it is probably true, as has been stated, that the common centipede does not come to maturity nor breed until it is at least three years old.†

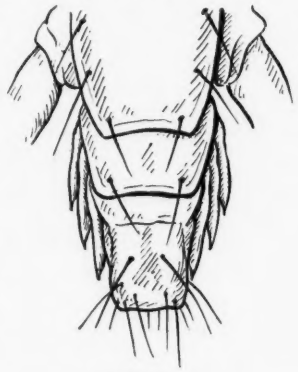


FIGURE 7.
The development of the thirteenth fourteenth and fifteenth pairs of legs.

* In the allied families of Cryptopidae, Scolopendridae, Notophilidae and Geophilidae, the young (see *The Cambridge Natural History*, Volume V., page 70) are hatched with the full complement of legs.

† The writer would be very grateful for specimens of any species of Centipede or Millipede from any part of Great Britain or Ireland, which could be sent to him, preferably alive, or preserved in spirit, to his private address, 8, Campbell Road, Hanwell, London, W.

THE FACE OF THE SKY FOR JULY.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.49 and sets at 8.18; on the 31st he rises at 4.23 and sets at 7.49. On the 5th at 1 a.m. the earth is at its greatest distance from the Sun, the solar parallax then reaching its minimum value of 8″·66.

Sun-spots may usually be observed on the solar disc in spite of the declining solar activity; at the time of writing, bright faculae are observable, but no spots.

The positions of the Sun's axis, equator, and the heliographic longitude of the centre of the disc, are shown in the following table:—

Date	Axis inclined from N. point.	Centre of Disc N. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
July 5 ...	1° 1′W	3° 24′	150° 16′
,, 10 ...	1° 16′E	3° 55′	84° 6′
,, 15 ...	3° 31′E	4° 25′	17° 56′
,, 20 ...	5° 43′E	4° 53′	311° 47′
,, 25 ...	7° 52′E	5° 19′	245° 38′
,, 30 ...	9° 57′E	5° 42′	179° 29′
Aug. 4 ...	11° 57′E	6° 3′	113° 22′
,, 9 ...	13° 51′E	6° 22′	47° 15′

THE MOON:—

Date.	Phases.	H. M.
July 6 ...	● New Moon.	9 20 p.m.
,, 14 ...	☽ First Quarter.	8 24 a.m.
,, 22 ...	○ Full Moon.	8 37 a.m.
,, 29 ...	☾ Last Quarter.	9 35 a.m.
Aug 5 ...	● New Moon.	6 37 a.m.
July 4 ...	Perigee	3 6 a.m.
,, 15 ...	Apogee	12 0 p.m.
,, 30 ...	Perigee	10 24 p.m.

OCCULTATIONS.—No occultations of naked eye stars are visible in this country during the present month or early August.

THE PLANETS.—Mercury (July 1st, R.A. $5^h\,17^m$; Dec. N. 21° 39′. Aug. 1st, R.A. $9^h\,38^m$; Dec. N. 15° 46′) is unobservable throughout the month, as he is in superior conjunction with the Sun on the 19th.

Venus (July 1st, R.A. $4^h\,1^m$; Dec. N. 18° 41′. Aug. 1st, R.A. $6^h\,37^m$; Dec. N. 22° 32′) is a morning star in Taurus, very little observable as she rises in the N.E. about 1.40 a.m. throughout the month. The apparent diameter of the planet is 12″, and 0·8 of the disc is illuminated.

On the morning of the 27th July, about 3 a.m., Venus will pass very close to or occult the star η Geminorum (the star is variable 3·2 to 4·2 in magnitude). It will be interesting to note the difference between an occultation by a planet and that one by the Moon.

Mars (July 1st, R.A. $8^h\,42^m$; Dec. N. 19° 33′. Aug. 1st, R.A. $9^h\,59^m$; Dec. N. 13° 31′) sets in the N.W. about 10 p.m. at the beginning of July, and about 8.30 p.m. early in August; thus the planet is in too bright a portion of the sky to be observable.

Jupiter (July 1st, R.A. $12^h\,24^m$; Dec. S. 1° 8′. Aug. 1st, R.A. $12^h\,37^m$; Dec. S. 2°41′) is getting more to the West, but still remains a conspicuous object in the evening sky, and is available for observation for a few hours after sunset, as he sets practically due West at 11 p.m. on 13th. On account of increased distance from the earth, the apparent diameter is diminishing, the equatorial diameter on the 20th being 34″, whilst the polar diameter is 2″·2 smaller.

The planet appears near the moon on the evening of the 12th.

Only few satellite phenomena are observable on account of Jupiter appearing in a bright part of the sky; these are as follows:—

Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
July 1	II.	Sh. I.	10 7	July 5	I.	Sh. I.	9 32	July 20	I.	Oc. D.	9 18
1	II.	Tr. E.	10 17	5	I.	Tr. E.	10 32	20	III.	Sh. E	9 36
2	III.	Ec. D.	9 28	8	II.	Tr. I.	10 10	27	III.	Tr. E.	9 9

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its reappearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress; "Ec. D." denotes disappearance of Satellite by Eclipse, and "Ec. R." its reappearance.

Saturn (July 1st, R.A. $2^h\,12^m$; Dec. N. 10° 49′. Aug. 1st, R.A. $2^h\,19^m$; Dec. N. 11° 16′) rises a little north of east on the 11th July at midnight, and on the 3rd August at 10.30 p.m. The planet is situated in Aries, and will be more favourably placed for observation during the next few months than he has been for many years past.

The ring, as seen in the telescope, appears well open, the apparent diameter of the outer major axis being 41″, and of the outer minor axis 12″·7; the southern surface of the ring is visible, and inclined to our line of vision at an angle of 18°.

The planet is in quadrature to the sun on the 30th July; the moon appears near the planet on the 29th.

Uranus (July 15th, R.A. $19^h\,41^m$; Dec. S. 21° 57′) is in opposition to the Sun on the 16th; hence about this date he appears due South at midnight. He can just be discerned with the naked eye about 5° S.W. of α and β Capricorni, and although rather low down is otherwise well placed for observation.

The planet's remarkable spectrum of broad dark bands is well worth the attention of observers, even though possessing only small instruments.

Neptune (July 15th, R.A. $7^h\,23^m$; Dec. N. 21° 27′) is not observable this month, being in conjunction with the Sun on the 12th.

METEOR SHOWER.—The most notable shower in July is that of the δ Aquarids, which occurs on the 28th. The radiant is situated in R.A. $22^h\,36^m$, Dec. S. 11°, and the meteors are slow with long tails.

XUM

The Perseid shower also commences about the 10th, the radiant being initially near *o* Cassiopeiae.

Mira (*o* Ceti) is due at maximum on the 3rd August, but as the exact date is somewhat uncertain, observations of magnitude should be made for some time before and after this date. The mean period is about 331 days. The star is also remarkable for its spectrum, which may be well observed in a 3-in. telescope, using a Maclean or Zollner spectroscopic eyepice; the spectrum consists of broad dark bands, in which bright lines, due to hydrogen, occur.

TELESCOPIC OBJECTS (Double Stars, &c.):—5 Serpentis, XV.^{h} 13^m, N. 2° 13′, mags. 5·1, 10; separation 10″.

β Serpentis, XV.^{h} 41^m, N. 15° 44′, mags. 3·8, 10; separation, 31″.

θ Serpentis, XVIII.^{h} 51^m, N. 4° 4′, mags. 4·0, 4·2; separation, 21″·6. Both are yellow, the primary being paler than the smaller star.

ξ Cephei XXII.^{h} 1^m, N. 64° 8′, mags. 4·7, 7; separation, 6″.

δ Cephei XXII.^{h} 26^m, N. 57° 57′, mags. 4·2, 7, separation, 40″. A pretty pair for small telescopes, stars respectively yellow and blue. It is also a typical short period variable star, not of the Algol type, the period being 5^d 9^h, with a sharp rise from minimum to maximum in 1^d 9½^h. There will be a minimum on the 5th at 12 p.m., from which other minima and maxima may be calculated from the intervals given.

Cluster in Libra, M 5. A compact cluster situated about one-third of a degree North of the double star 5 Serpentis; it appears like a large nebulous star when viewed with a pair of opera glasses.

Cluster in Serpens, N.G.C. 6633; about one-third of the way from θ Serpentis to α Ophiuchi. The cluster is visible to the naked eye.

SOLAR DISTURBANCES DURING MAY, 1910.

By FRANK C. DENNETT.

DURING May there was considerably more activity on the Sun than during the previous month, and the disc was not once free from spots. The longitude of the central meridian at noon on May 1st was 290° 19′.

No. 33 continued on the disc until May 11th and so re-appears on the present chart.

No. 34.—A tiny pore only seen on 2nd.

No. 35.—In a faculic district a single pore seen 4th only; on 6th two 37,000 miles apart, gone next day, only leaving the faculae.

No. 36.—A black pore with three greyish dots 44,000 miles to east, only seen 5th.

No. 37.—A close pair of pores very near the centre on 7th only. On the 12th two larger spotlets appeared, 43,000 miles apart, in a faculic cloud near west limb, but not visible after.

No. 38.—A single spot at first, which increased to 10,000 miles in diameter; pores showed about it 12th to 15th; and its penumbra had the inner edge fringed more brightly 14th 16th. It was seen 7th to 19th. Length of the group 36,000 miles.

No. 39.—A single spot near the eastern edge on 12th, 15,000 miles in diameter; the umbra became bridged and a smaller one formed as the spot dwindled, being last seen on 22nd, leaving only a cloud of faculae in its place. The inner edge of the penumbra was noted bright-fringed 14th to 16th and 18th.

No. 39a.—A little group of pores south east of No. 39, subject to constant change, 14th to 16th.

No. 39b.—Pores 16th and 17th closely south of No. 39, on 18th a little group 23,000 miles in length, showing great activity in spectroscope, only one pore remaining until next day.

No. 40.—First seen as two spotlets on 14th, the western one increasing to 24,000 miles in diameter, leading a group of smaller members which had a total length of 89,000 miles. The great spot showed constant change, and as it reached the central meridian on 19th its influence doubtlessly was felt by the magnets, the disturbance of which had been supposed by some to be due to the effect of Halley's Comet.

No. 40a.—A solitary and evanescent pore, only seen on 21st.

No 41.—Two pores, the eastern one 50,000 miles behind, and 33,000 miles farther south of its companion, 19th to 23rd. On 23rd two pores were seen near each other.

No. 42.—A pair of spotlets, 17,000 miles apart, developed west of No. 39, on 21st to 23rd.

No. 43.—A Protean group, two pores 21st, four 22nd, and only one 23rd, when last seen. The greatest length was 33,000 miles.

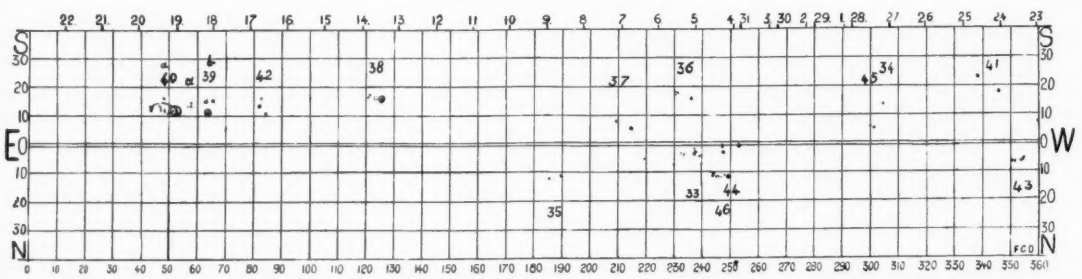
No. 44.—A group of pores, with a maximum length of 45,000 miles, at the western end of a faculic area, seen May 25th to 31st. One pore showed again, June 1st to 3rd.

No. 45.—A small close pair of pores near the centre, only seen 28th.

No. 46.—A triangle of three pores 29th; next day a line of three. By June 1st, a group 52,000 miles in length. Two of the members increased somewhat by 3rd, but only remained visible until 5th, faculae afterwards showing the place.

The Chart is constructed from the combined observations of J. McHarg, A. A. Buss, E. E. Peacock and F. C. Dennett.

DAY OF MAY.



PHOTOGRAPHY—PURE AND APPLIED.

By CHAPMAN JONES, F.C.S., F.I.C.

INTENSIFICATION.—After a certain stage in the development of a negative it merely increases in density until the photographer judges that he has obtained sufficient contrast. This degree of contrast has to be guessed at, unless duplicates are being made under known conditions, because a negative cannot be tested in any definite way during development. If, when the negative is being printed from, it is found to be lacking in contrast, it is clear that we need a process that will give exactly the same result as a little more development would have given, so that the needed contrast or vigour may be obtained without any change in the character of the negative. The only method of intensification that has been proved to do this is the mercury and ferrous oxalate method. If the treatment with mercury is followed by sodium sulphite the result approximates to the prescribed standard, but this process involves the loss of a large proportion of the silver of the original image, and it cannot be repeated, as the total material that forms the image is lessened by it. The mercury and ammonia as well as the mercury and silver cyanide processes never give uniformly proportional effects, and always yield an image that will change, sometimes disastrously, with time. The mercury and ferrous oxalate method stands alone in preserving the quality of the negative, in giving a stable image, in losing none of the original silver, and in giving an image that equals the original, unintensified image, in the ease with which it may be subjected to any other treatment, including further intensification.

It is now more than twenty years since I pointed out the advantages of this method, and in a communication recently made to the Royal Photographic Society I have given further proof as to the stability of the image, and the results of the examination of various proposed alternative methods. These alternatives, some of which have been often recommended, all fail in the essential requirements indicated above. They do not give proportional results, so that the character of the negative is changed by them. The only substitute for ferrous oxalate that gives approximately the same effect is an alkaline solution of formaldehyde, and the most that can be said of this is that with care it *may* prove satisfactory, but it has many disadvantages that ferrous oxalate is free from. I believe it is true that in all cases these alternatives have been proposed without any examination of them further than the fact that they blackened the image as bleached by mercuric chloride. Their faults are many and various, and for further details reference should be made to *The Journal of the Royal Photographic Society* for last month.

TELEPHOTOGRAPHY.—Although one cannot but regret that Captain Owen Wheeler has been obliged to discontinue his *Telephoto. Quarterly*, he is to be congratulated on having done more than anyone else to popularise telephotographic work. He has not simply advertised it and urged it, but made two distinct improvements in the general practice of it, which, although they may seem trivial, often mean all the difference between success and failure. The first is the use of an efficient shade for the lens that keeps out of it all extraneous light which used so often to be the cause of thin and fogged images in work out-of-doors. This shade is a light tunnel extending in front of the lens, with a rectangular adjustable aperture at its more distant end. The second matter that Captain Owen Wheeler has shown the advantage of, is the use of a comparatively short camera extension and the getting of different magnifications by varying the negative lens. This renders ordinary cameras available without any undue curtailment of variation in the magnification, and tends to obviate the risk of vibration that is a great trouble with long camera extensions. It is to be hoped that these practical details will be kept in mind, although the author of them is not able to maintain his active advocacy of them.

COLOUR PHOTOGRAPHY.—The third exhibition of the Society of Colour Photographers, at 24, Wellington Street, Strand, will close on the 9th inst. Screen-plate colour transparencies on "Dufay" plates are the novelties of the show, but it is, as might be expected, not easy to distinguish these from autochromes, or transparencies on "Thames" plates. The perfection of the reproduction of colour is in all such cases largely a matter of skill, and it is impossible from a few examples to discover which of these plates is the most advantageous. It is not possible to say how much of the success is due to the worker and how much to the plate, nor, indeed, to gauge the success as a whole with any degree of accuracy, in the absence of the original objects. But colour photography on screen-plates may be said to have passed this preliminary stage so far as exhibitions are concerned; they have been proved suitable for the work for which they are made, and those who use them must decide for themselves which plate they prefer. This being so, it is a little disappointing to see so many photographs made apparently merely in order to demonstrate the power that these plates put into the hands of photographers with regard to commonplace subjects. The "Thames" Plate Company are the only exhibitors who show duplicate colour photographs. They have four prints made from the same negative taken behind a three-colour screen of their well-known pattern, each of the four prints being backed by a colour screen. This inter-changeability of colour screens is a great desideratum, and these examples show a considerable measure of success. Of the prints on paper, the three-colour carbon prints of Mr. Clifton and the three-colour collotypes of Mr. Hollyer, as well as other examples, show what excellent results are possible by these methods in skilled hands. There do not appear to be any examples of the technical applications of colour photography processes, except in portraiture and a few copies of pictures. The one lesson that the exhibition teaches is the possibilities of the various methods, and that excellence is now a question of the worker rather than of the materials.

THE CONGRESS.—The fifth International Congress of Photography that is to be held at Brussels is definitely announced to extend from the first to the sixth of August. Besides the ordinary meetings, at which many questions of universal interest will be discussed, there will be various demonstrations, visits and excursions, and a banquet. Communications are announced from a large number of well-known workers of all nationalities, and the success of the Congress seems to be already assured. The International Exhibition will, of course, be an additional attraction to visitors. Those who wish to become members may send their subscriptions, eight shillings, to Mr. Chapman Jones, 11, Eaton Rise, Ealing, London, W.

THE ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION.—Those interested are reminded that exhibits must be delivered, if by carrier not later than 6 p.m. on August 5th, and if by hand on August 6th. Full particulars can be obtained by application to the Secretary of the Society, at 35, Russell Square, W.C.

XUM

A RECORD.

THE BATTLEDORE-WING FLY.

MYMAR PULCHELLUS.

By FRED ENOCK, F.L.S., F.E.S., F.R.M.S.

To the enthusiastic Student of Nature anything in the way of a record capture of a rare insect is something to remember, and makes a far deeper impression on the mind of an entomologist than all the sporting records of the world. It may occur out in the field after a hard day's work, or at home in the quiet breeding boxes, where, year after year, experiments and "dodges" have been carried on in the endeavour to trace out some unknown fact in the life-history of a certain insect. Among the various insect orders, the gaudy colours of the Lepidoptera have always attracted the greatest number of students, while the many neglected families among the Hymenoptera still want enthusiasts to take them under their care, christen the many species that are yet without names, and introduce them to Science. Though they are not of such beautful colours, the Hymenoptera possess the highest insect intelligence, which, as Lord Avebury writes, "only differs from our own in a matter of degree."

For the past thirty-five years, I have taken under my special care the long-neglected family of ovivorous parasites, the Mymaridae, which Andrew Haliday first established in 1833, but soon turned them over to Francis Walker, who seems to have let them slide into the hands of Foërster, who, following the example of Haliday and Walker, only described, and made no figures—without which, with a few exceptions, it is impossible to identify closely allied species.

In 1857 the Rev. T. A. Marshall first discovered the Battledore-wing Fly at Richmond Park, and Curtis gave a correct and most beautiful figure of it in his *British Entomology*, plate 411.

It was the first sight of this figure that fired my enthusiasm to know more of this wonderful insect, but eleven years passed before I captured my first specimen, in a spider's web in my garden at Holloway! Ever since that red letter record, I have searched for its nidus—dreamed I had found it—but though I often each year used to search herbage and grass, whilst lying flat on my stomach, I never traced it, for its movements were so rapid and its size (only about a twentieth of an inch long) so small, that year after year went by without adding much more than an occasional specimen—and noting its habit of carrying its wings a slight distance apart, with the tips over the body (see Figure 4). In this position it ran very quickly up and down the stems and then—disappeared!

With my head buried among the grass and herbage, I gained much valuable knowledge of the habits of others of the Mymaridae, as well as of larger species, especially ants, which were too attentive and inquisitive, as well as annoying, but if we desire to learn the "ways" of these small creatures we must get as near to them as possible, and allow them to do the same to us.

Link by link and sometimes only half a link was added to the life-history of one or another of the near relatives of the Battledore-wing Fly, to *breed* which was the acme of my ambition.

I had watched so many of these ovivorous parasites searching leaf and stem to discover the right egg in which to deposit their own, and, should any sceptic doubt the intelligence of an insect, I would advise him to watch one so engaged. First, a rapid run up the stem or about a leaf, the clubbed antennae being kept in constant vibration, when suddenly its speed is slackened and it "slows down," and with those mysterious clubs sounds the leaf, and appears to be concentrating the whole of its brain power to ascertain the exact locality of the egg, which, when found, receives several smart raps from the antennae, and, should it prove to be the right egg, the Mymarid immediately mounts over it and drives its ovipositor through (often a long process) depositing one or more of its own eggs, and the doom of the host is sealed.

The power which these microscopic insects possess of identifying the egg is simply incomprehensible, but, nevertheless, I am willing to bow to their knowledge and correct selection.

Acting on what I had observed, I was rewarded by breeding a male and female Battledore-wing Fly for the first time on record, on June 14th, 1910.

I have yet to unravel the mysteries of its life history. The general colour of the insect is orange. The male, Figure 1, has thirteen joints in its antennae, the female, Figure 2, nine joints, the abdomen being petiolated. The hymenopterous character of the insect is seen in the wings being hooked together, Figure 3 on the left side hooked. The right side shows the lower wing free, a mere bristle with the three minute hooklets. Towards its tip the upper wing is shaped like a long-handled battledore, the margin of which is surrounded by long cilia.

To face page 256.

FIGURE 1.

The Battledore-wing Fly, *Mymar pulchellus*, Male.
Magnified 16 diameters.

FIGURE 2.

The Battledore-wing Fly, *Mymar pulchellus*, Female.
Magnified 16 diameters.

FIGURE 3.

Position of Wings and Antennae of *Mymar* when running up and down stems and leaves.
Magnified 16 diameters.

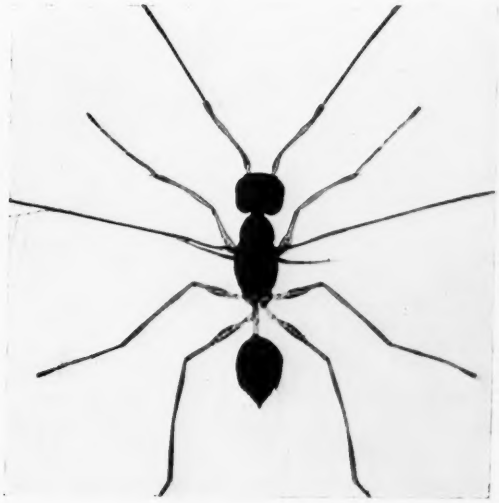


FIGURE 4.

The left wings are shown hooked together. The right posterior wing (a mere bristle) shows three hooklets.
Magnified 38 diameters.

The figures are all from photomicrographs by Fred Enock, F.L.S.

XUM

XUM

CORRESPONDENCE.

NEWTON ON THE EARTH'S MOTION.

To the Editors of "KNOWLEDGE."

SIRS,—Professor Minchin has given, in the May issue of "KNOWLEDGE," a translation of the Declaration of the learned Fathers Le Seur and Jacquier, of the Order of St. Francis (not Jesuits) in the preface to their edition of Newton's Principia, from a re-edited volume in 1822, Glasgow. We have here the original edition, in four volumes, published in Geneva between the years 1739 and 1742. The "Declaratio" appears at the beginning of the third volume. It is not a part of the author's preface. It is not even printed on the last page of the preface, where there is room for it, but on a separate leaf. It is not, therefore, covered by the author's attestation or signature to the preface, in the usual Roman form: Datum Romae in Conv^{tu} S^{ae} Trinitatis Anno Domini 1742. These are the only remarkable facts about the statement; and although they are surprising, I do not mean to question the authenticity of the declaration, for it is only what in substance was to be expected under the circumstances, although expressed, perhaps, in words with too much regard to Ciceronian phrase. We have, also, a similar declaration by the celebrated Jesuit physicist, Roger Boscovich, at the beginning of a Dissertation de Cometis, read in the Roman College in 1746, and published in Volume III of his Opera pertinentia ad Opticam et Astronomiam, in 1785, Venice. His words are worth reproducing, because they show that he held to the literal meaning of the loca Scripturarum independently of the decrees against Galileo, and that this was no impediment to progress in Astronomical studies. The sentence runs:—

"Newtonus quidem terram movet. At nos sacrarum litterarum testimonia venerati, et Sacrae Inquisitionis decretis obsequentes, immotam statuemus, ejusque motum nonnisi in speciem tantum retinemus facilioris deliniationis gratia, illud simul demonstrantes, sive terra circa solem moveatur, sive cum sole comitarum orbitae circa terram immotam circumferantur, eadem prorsus phaenomena provenire, easdemque motuum causas, ac vires corporum perseverare."

I hope Professor Minchin will correct me if I have taken a wrong view of the interest he attaches to the Declaration of the Franciscan Fathers; for I have failed to satisfy myself that I see in what way it can be of interest to the readers of "KNOWLEDGE."

Two suggestions have been made to me.—1. That the words "*Hinc coacti sumus alienam gerere personam*" implies duplicity on the part of the authors; and, although I do not see how this can be interesting, I may remark that although the translation is correct, the word character, when not used in connection with the stage, is not so clearly understood as the *Latin* word *persona*, which shows the meaning to be that in the subject of the volume the authors are appearing, as an actor on the stage, in a character not their own.

2. It has been said that the words which follow "*Coeterum latis a summis Pontificibus contra telluris motum decretis nos obsequi profitemur*" (But we declare our submission to the decrees . . . .) show that the authors believed that the Earth's motion had been so condemned that in spite of the evidences contained in the volume they were bound to withhold their assent to the conclusion. This suggestion will need more careful consideration: it cannot be fully treated within the limits of a letter to "KNOWLEDGE," but I do not despair of making it clear that our authors were under no such obligation; that they expressed themselves perfectly by the words *obsequi profitemur:* that the decrees went no further than a prohibition to expound the new doctrine in other sense than as a working hypothesis awaiting demonstration.

In order to interpret the decrees correctly, it is necessary to go back before the decrees were thought of, and to go behind the scenes when the decrees were formed. There is no doubt that Galileo had found in Pope Urban VIII (who sent his work before the Court of Inquisition) his greatest friend and supporter amongst a crowd of Prelates and Princes, who idolized the new philosopher, and so, probably turned his brain, and let loose in him that natural headstrong obstinacy, so bluntly described by the Tuscan Ambassador writing to his Master, Prince Cesi, Galileo's life-long patron. He had had distinct assurances from Cardinal Barberini (afterwards Urban VIII) and from Cardinal Bellarmine that he would not be troubled if he would but confine himself to the system and its demonstration, without trespassing in the domain of theology. But he could not be kept quiet. He would not accept the advice of his friends. On the contrary, both in season and out of season, of himself and through others, he insisted upon a declaration in favour of his own interpretation of the loca S.S. quoted against him. And, however much we may regret the steps taken by Urban, we cannot wonder that he did employ the only legal means within his reach to secure the silence which Galileo refused to friendly advice.

Nor, indeed, if the circumstances of the time are properly understood, can we justly regret that the Holy Father, who held the commission to "feed my lambs" as well as "my sheep," took the means to stop interpretations of Scripture which were already becoming a source of scandal to the multitude of the weaker members of the flock. The dialogue was condemned, and its author's punishment was imprisonment during the will of the Pontiff.

I have already shown, from Galileo's letters (Journal Brit. Ast. Assoc., March) that this imprisonment was little more than nominal, with power at the back of it to make it real in case of need. I have again searched the letters to find, if possible, some complaint of his having been ordered to condemn the new astronomy. I have found none; and, judging by the tenor of his many letters, this silence, if silence can be called eloquent, is an eloquent admission on the part of Galileo that the condemnation did not go beyond the meaning contained in the assurances already given to him officially by Cardinal Bellarmine, in 1616; and that he understood the form of abjuration, which he was afterwards called upon to make in 1633, to be only in accord with the formalities of the Court, which could not be altered any more than our own Court of King's Bench could alter the form "vi et armis" to suit a civil case which had been qualified as violence in order to bring it within the jurisdiction of the court.

That there were men at the time who would have nothing but the most literal meaning attached to the formal decree of the Office we learn from many passages in the letters, where Galileo speaks of the machinations of his enemies. And this is not surprising; for, there was at that time an army of staunch Aristotelians who would not pass by the opportunity of making the most of a condemnation. And even Boscovich, a century later, considered it so much an irreverence to the inspired writings to treat of the earth as a moving body that he laboured, as he tells us, to show that an immovable earth was not impossible in the Newtonian system of universal gravitation.*

But apart from Galileo's own understanding of the censure passed upon his book, knowing the origin of the prosecution, the formalities of the court, and the friendly relations between Galileo and the highest dignitaries of the Church before he had assumed the rôle of a Doctor of Theology, there is no room for doubting the correctness of Galileo's tacit interpretation of the condemnation. It is impossible to suppose that Pope Urban VIII meant the condemnation of a doctrine which he himself, along with many others in high places, had favoured so greatly and so openly. But the time had not yet arrived for dealing with the first-sight meaning of the Scriptural texts relating to

*(Note appended to the Dissertatio de Cometis for publication in 1785. In the same note the Author contends that Newton had thrown a new light upon the Copernican doctrine: so new, that it was false to assert that the Copernican system was at last followed in all schools and so on: not the Copernican, but the Newtonian was the system followed, the former holding an immovable Sun, the latter a Sun in motion).

XUM

the stability of the Earth. "We want proofs," said Cardinal Bellarmine; and again "We may be obliged eventually to interpret otherwise than hitherto."

But the proofs were wanting; and Galileo's only support to the system was the more simple explanation of the motions in the heavens than was offered by the Ptolemaic epicycles: for the direct proof which he advanced, and made so much of, from the flux and reflux of the tides, is admittedly mere nonsense. And the surprise he expressed at what he called Kepler's simplicity in attributing the tides to the influence of the moon, shows us how remote he was himself from the true conception of the celestial movements first made known in the Newtonian system which eventually carried both Rome and the World.

Our author's words therefore "decretis . . . obsequi profitemur" (We declare our submission to the decrees) can be understood only as an assertion that they, with Boscovich, do not go beyond the limits of a happy hypothesis; and we may well believe that they had at the time a hope that they were complying with the request for proofs of the motion. They lived to see the censures withdrawn.

WALTER SIDGREAVES, S.J., F.R.A.S.

STONYHURST COLLEGE OBSERVATORY.

June, 1910.

EDMUND HALLEY.

To the Editors of "KNOWLEDGE."

SIRS,—I should be glad if you would insert this in order to correct two or three misprints, though obvious, one in the numbers for May and June.

On pp. 165 and 166, in the text and figure 2, Helvelius should be Hevelius, being the latinised spelling for Johann or Jean Hevel.

On p. 215, figure 1, Jacob Bradley should be James Bradley; on p. 217, for Hornsley read Hornsby; and on p. 218, second column, line 10, for Halley's read Rigaud's.

Yours faithfully,

F. A. BELLAMY.

UNIVERSITY OBSERVATORY, OXFORD.

June 24th, 1910.

SO-CALLED CRATERS OF THE MOON.

To the Editors of "KNOWLEDGE."

SIRS,—Your correspondent, Mr. H. L. Meadows, ("KNOWLEDGE," vol. XXXIII, p. 235,) will find much information on this subject in an article by Professor See, in *Publications of the Astronomical Society of the Pacific*, vol. XXII., p. 13, and articles indirectly bearing upon the same subject in various numbers of the *Astronomische Nachrichten* (Kiel) during recent years. The paper by G. K. Gilbert, the geologist, is in the *Bulletin of the Philosophical Society of Washington*, vol. XII. (1892). An exhaustive article is promised by Prof. See in his forthcoming Vol. II of his "Researches."

Yours truly,

THE WRITER OF THE NOTE.

June, 1910.

THE CRATERS OF THE MOON.

To the Editors of "KNOWLEDGE."

SIRS,—In answer to Mr. H. L. Meadows, the paper of Professor T. J. J. See, Director of the U.S. Naval Observatory, Mare Island, referred to, has been published in "*Publications of the Astronomical Society of the Pacific*," Vol. XXII., Nr. 130, February, 1910. Its exact title is, "The origin of the so-called craters of the Moon by the impact of satellites, and the relation of these satellite indentations to the obliquities of the planets." It is an eight-page paper, with four illustrations: (1) A full-page plate reproducing a beautiful negative of the Moon, eight days old, taken by Loewy and Puiseux at the Paris Observatory; (2) A figure showing "Imprints of Raindrops," from Chamberlain and Salisbury's Geology; (3) A diagram illustrating the formation of crater by impact of satellite; (4) A full-page plate photograph representing "Indentation of leaden target by bullets, from experiments made by Capt. A. W. Dodd, U.S.N., at Mare Island." This paper is not dated. Apply for "*Publ. A.S.P.*" to the Secretary-Treasurer, Mr. D. S. Richardson, 748, Phelan Buildings, San Francisco, Cal.

It may be added here that this paper partly refers to other papers titled and published by the same astronomer, as follows:—

(*a*) "Dynamical theory of the capture of satellites, and of the division of nebulae under the secular action of a resisting medium," with two plates ("*Astronomische Nachrichten*," Nr. 4,341-42, Band 181, Nr. 21-22, Columns 333 to 350), dated 1909, May 6, published 1909, July 22.

(*b*) "Origin of the lunar terrestrial system by capture, with further considerations on the theory of satellites, and on the physical cause which has determined the directions of the rotations of the planets about their axes." ("*Astronomische Nachrichten*," Nr. 4,343, Band 181, Nr. 23, Columns 365 to 386,) dated 1909, May 22, with an "Addition" dated July 3, published July 31.

(*c*) "Further considerations on the theory of the rotation of the principal planets, and on the growth of the minor globes which have finally become satellites," ("*Astronomische Nachrichten*" Nr. 4,358, Band 182, Nr. 14, Columns 213 to 218), dated 1909, July 20, published September 24.

His, however, are not "popular" papers.

Professor See, furthermore, announces a more full discussion of the matter, in relation with many other problems, in Vol. II. of his "Researches on the Evolution of the Stellar Systems" recently advertised, and which must now, I think, have appeared.

It should be noted that the first page of Professor See's abstract in "*Publ. A.S.P.*" bears a foot-note saying: "The responsibility of the views here set forth rests with the author, and not with the Society or the Committee on Publications."

Mr. Meadows should read the "text" of the Paris photographic atlas of the moon, just finished, or see the somewhat reduced but cheaper edition of this remarkable piece of work, published by the "Societé Belge d' Astronomie," of Brussels. Perhaps he would then somewhat modify his views on this question.

Yours respectfully,

FELIX DE ROY.

ANTWERP,
RUE PYCKE, 55.
June 20, 1910.

METEORITE OF APRIL 25th—JUNE METEORS.

To the Editors of "KNOWLEDGE."

SIRS,—Captain C. F. Dobbs gives a very interesting account of the meteorite which fell in Bombay Harbour on April 25th, and asks "could it have been a Lyrid?"

The radiant of the Lyrid meteors was far below the northern horizon of Bombay at the time of the meteorite's descent, so it could have had no association with that well-known shower. No Lyrid fragment has ever fallen upon the earth as far as is known; in fact the productive streams of swift meteors, such as Perseids and Leonids, seem to have their atoms finally burnt out in our atmosphere at a good height (forty-five miles to sixty miles) and rarely descend lower. It is the slow meteors overtaking the earth in her orbit which penetrate the air so deeply and occasionally fall upon the ground. Atmospheric resistance and terrestrial attraction both influence the fall of meteorites and sometimes overcome their original velocity and direction, especially in cases where the meteors are of large size and capable of withstanding disruption through a long flight.

In my letter on "Midsummer Shooting Stars," I regret that the misuse of a word has occasioned an apparent contradiction. I meant to say that the twilight and brevity of June nights seemed *uninviting*, yet that such meteors as appeared were *very interesting* from their conspicuous aspect.

Yours obediently,

W. F. DENNING, F.R.A.S.

BRISTOL,
June 14th, 1910.

GENDERS IN ZOOLOGY.

By THE REV. T. R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S.

BARBARISM and civilisation agree in the policy of binding the human race in needless fetters. Anyone who seeks to ease or remove them, instead of being praised as a philanthropist, is liable to be charged with impiety, anarchism, or fantastic folly. There are tribes in which a man who walked abroad in an unaccustomed hat or without a hat at all, would be deemed either a barefaced conspirator or a victim to softening of the brain. Thus even the innocent proposal which I am about to make may be condemned as a serious misdemeanour by the very naturalists for whose benefit it is being made.

My suggestion is that a technical specific name in Zoology should be released from the obligation of agreeing with the supposed gender of the generic name to which it is attached.

Simplicity would be attained by acceptance of the convention that in Zoology a generic name, whatever its termination, is to be regarded as of the masculine gender.

That some scholarly ear might occasionally be offended, is a minor disadvantage compared with the general utility of the convention. A famous historical character was hailed as "our king Maria Theresa," without any influence on the actual sex of that distinguished person. Similarly many men have been named Maria without in consequence becoming women or in any degree effeminate. The termination of a generic name is a very indifferent reason for determining a zoological species as either masculine, feminine, or neuter, seeing that the species itself usually includes two of the genders, and sometimes all three. Very commonly all the normal individuals of a species are either of the male or female sex. Yet, under the existing rule, the species must sometimes have a neuter name, as though it referred to something inorganic or of undiscriminated sex. Such considerations, however, are of subordinate importance compared with the troublesome character of the present arrangement. As everyone is aware, it repeatedly happens that by accessions to knowledge, genera become unwieldy and have to be subdivided. The new names, it may be, do not agree in gender with the old, and then the transferred species must all have their terminations altered. But, apart from this consequential trouble, naturalists for ages past have found the determination of generic genders a stumbling-block. How much more is this likely to be the case in the future, with the continuous decline of classical studies! Without actual examples, few would credit the difficulties encountered and the errors committed by naturalists in their endeavours to comply with the existing rule or practice.

Names of Greek origin, such as *Nymphon*, Fabricius, 1794, *Potamon*, Savigny, 1816, *Kepon*, Duvernoy, 1841, are of some interest. The first of these suffered correction into the neuter form *Nymphum*, at the hands of Leach. But this Pycnogonid genus derives its name from the masculine word *νυμφών*, the bride-chamber. Savigny's *Potamon fluviatile* was called *Potamophilus edulis* by Latreille in 1818. In 1904 Miss Rathbun calls it *Potamon edulis* (Latreille), and Mr. Gurney writes *Potamon edule* in 1909. Now *Potamon* is no doubt the genitive plural of *ποταμός*, a masculine noun, and means "of the rivers." In like manner *Kepon typus* Duvernoy, undoubtedly owes its generic name to the Greek equivalent, a masculine genitive plural, meaning "of the gardens," since the name was given in compliment to Duvernoy's friend Desjardins. In later years we have *Cancrion miser*, Giard and Bouvier, in which the gender of the genus must be inferred from that of the species. *Crangon*, the genus of the common shrimp, from the feminine Greek word *καραγγών*, allows the celebrated naturalist, Alphonse Milne-Edwards, to write at one time *Crangon spinosus*, and at another *Glyphocrangon nobile*, thus using masculine and neuter specific names in combination with a feminine generic term. In 1905 the late Mr. Buckton described the species *Taloipa tinctoria*, in the family Membriacidae. It will be pardonable, I think, if in the future a Master of Arts in some learned university should regard *Taloipa* as a feminine word, derived perhaps from an Indian goddess. But as a matter of fact it is a neuter plural transliteration of the Greek *τὰ λοιπά*, so that for accurate syntax a neighbouring species would have to be called, not *Taloipa affinis*, but *Taloipa affinia*.

Most of all, perplexities arise when generic names end in the first letter of the alphabet. The natural man presumes that such words must be feminine. Thus we find the illustrious Darwin forgetting the fame of Shrewsbury School for accurate scholarship, so that he writes *Conchoderma aurita*, *Poecilasma aurantia*, and so on, for generic names that are neuter. Down to the most recent times we meet with a crowd of similar combinations, such as *Microschema mucronata*, *Cuma bella*, *Bathycuma elongata*, *Eocuma taprobanica*, *Haliophasma purpurea*, *Tanysoma angusta*, *Merisma sharpiana*, *Allorisma concinna*. These illustrations of neuter endings mistaken for feminine might easily be multiplied. At times it is a masculine ending that proves deceptive, as in *Petauriosa nitida*, where the generic name is a masculine word, meaning a rope dancer. *Carbonicola acuta*, *Arenicola marina*, are used evidently in ignorance of the fact that words formed like *agricola* and *incola* are of common gender, and therefore, in the

XUM

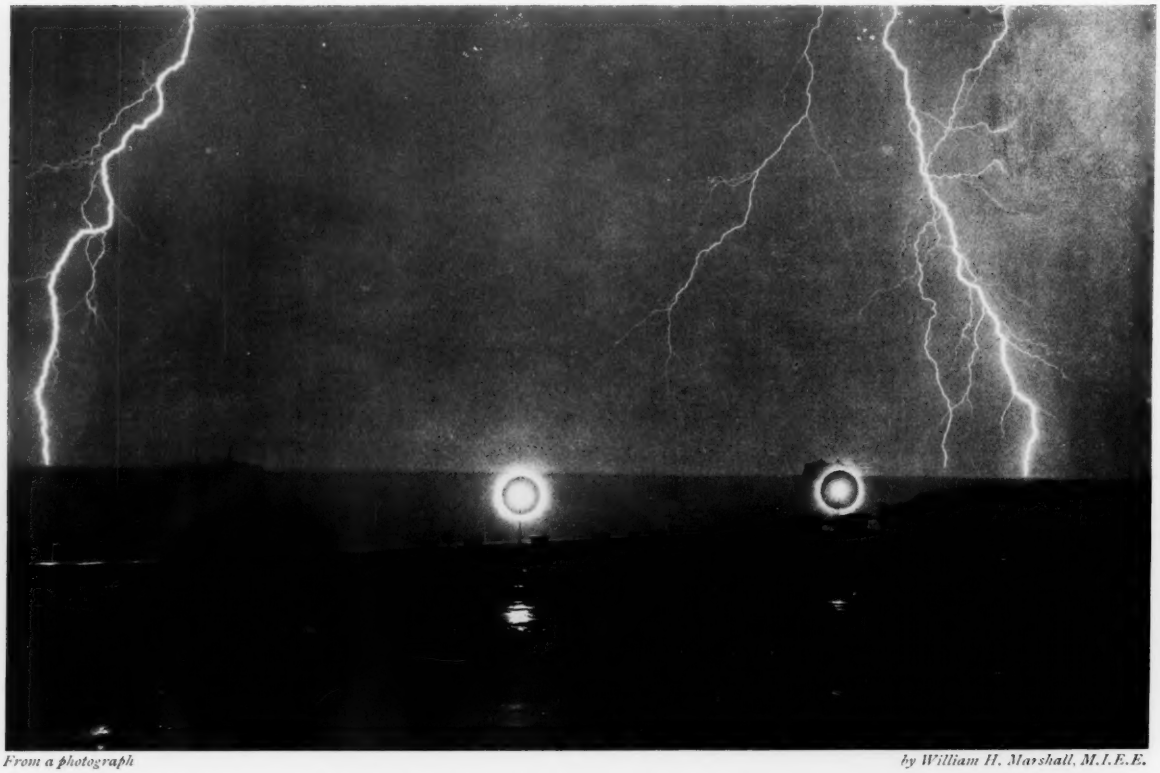
Latin idiom preferentially masculine. Stimpson, when transferring *Maera confervicola* to another genus, called it *Gammarus confervicolus* instead of retaining *confervicola*, as he should have done. A scholar, remembering Lars Porsena or Porsenna of Clusium, might readily think that the use of a masculine specific name in *Bircenna fulvus* was quite correct, but, as it happens, Bircenna is the name of a lady, not of a laird.

Names that end like *Ptychognathus* are usually masculine, yet, because γνάθος is a feminine word, *Ptychognathus glaber* is named in violation of the existing rule. What shall be said of *Comanthus intricata* and *Comaster multiradiata*, seeing that ἄνθος is neuter and ἀστήρ is masculine? On the other hand we have *Neomaenis griseus* for "the grey snapper," and *Tentaceras reticulatus* for a West Indian starfish, although μαινίς, a sprat, is feminine, and κέρας, a horn, is neuter. These two examples are taken from the reports in 1907 and 1908 of the enlightened Carnegie Institute, and are perhaps an endeavour to support by usage the proposal here advocated. Spasmodic efforts of this kind have been made before now. But they have been ignored, exposed to what is deemed correction, or otherwise put out of countenance. They need to be protected by a sanction of some kind, such as might be offered by Section D. of the British Association or by the International Congress of Zoology. It has been said in politics that "force is no remedy," and in zoological nomenclature there is no obvious mode of bringing it to bear on editors or independent writers. It is true that the "force" of public opinion is highly efficacious, though it is neither physical force nor statutory obligation. But on the present subject-matter, public opinion is difficult to enlighten, difficult to ascertain, difficult to concentrate.

The object of this article will have been attained, if, in the coming assemblies of zoological experts, the question is submitted to serious debate. The appeal is made to naturalists to save themselves from needless trouble by abolishing a rule which is full of pitfalls for any but classical scholars, and into some of which Homer himself might have stumbled in a moment of drowsiness.

Homeric blunders, made by men of high repute in their own specialities, might be quoted to excite a smile, but the real absurdity lies in the fantastic syntax over which they have very often tripped.

A PHOTOGRAPH OF LIGHTNING FLASHES.



From a photograph by William H. Marshall, M.I.E.E.

This picture was taken at 9 p.m. on June 9th, from the top window of South Parade House, Southsea. The two main flashes occurred simultaneously after the plate had been exposed for five or six seconds. On the left of the picture is H.M.S. Invincible, and on the right Spit Fort, of which a light can be seen. The halos round the arc lamps are caused by the heavy rain, and are not due to halation of the plates.

A SIMPLE MERIDIAN MARK.

By E. ARDRON HUTTON, M.A.

SOME of our astronomical readers may be glad to hear of a simple and yet highly efficient meridian mark that was set up by the writer about five-and-twenty years ago, and which was sufficiently accurate to obtain Greenwich time to within a few seconds, thus obviating the need of a transit instrument while serving every practical purpose. The whole apparatus is simplicity itself, and the portion which is original is small and easily constructed, whilst adding much to the exactness and efficiency of the whole.

It is necessary first of all to give an approximate plan of the whole which will probably be self-explanatory.

S indicates the position of the Sun at noon. H is the corner of a house which thus cast a shadow at noon on M, the position of the meridian mark.

To set the mark we require three things, all of which are easily ascertained—the longitude, the equation of time and Greenwich time.

The longitude was obtained from a six-inch to the mile Ordnance map. This happened to be 1° 59′·2 West of Greenwich, which when converted into sidereal time becomes :—

		min	sec
1°	=	4	0
59′	=	3	56
0′·2	=		0·8
		7	56·8

which converted into mean time becomes :—

		min	sec
7 min	=	6	58·853
56 sec	=		55·847
0·8	=		0·798
		7	55·498

or approximately 7 min. 55·5 seconds mean time. Thus local time, due to longitude, was 7 min. 55·5 seconds after Greenwich.

The equation of time for each day may be obtained exactly from the Nautical Almanac, or to the nearest second from Whitaker, where it is given as Sun "before" or "after" Clock. When the sun is "before Clock" the figure must be subtracted from 12 o'clock plus local variation. For instance on November 17th this year the Sun is "before Clock" $15^{mins}\ 3^{secs}$ and thus we get :—

	hrs	min	sec
	12	7	55·5
less		15	3·0
	11	52	52·5

as the time when the Sun souths at the above station. If Whitaker gives Sun "after Clock" the equation of time must be added to 12 o'clock plus local time.

Thus on February 12th this year we have Sun "after Clock" $14^{mins}\ 25^{secs}$ Hence we get :—

	hrs	mins	secs
	12	7	55·5
plus		14	25·0
	12	22	20·5

as the time of transit for the above station on that day.

We must next get Greenwich time or rather the error of our watch, by proceeding to the nearest railway station a little before 10 a.m., waiting for the daily time signal at that hour, and noting the difference of our own watch from it. Let us suppose our watch to be 25^{secs} fast.

Going home to our own station we make the above calculation for the day, plus 25 seconds for error of watch. (If the watch were slow we must deduct the error of watch). Taking the figures above for February 12th we have :—

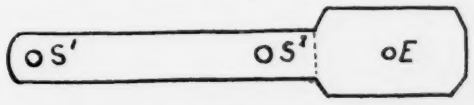
	hrs	min	sec
	12	22	20·5
plus watch error			25·0
	12	22	45·0

We note the shadow of the corner of the house, and at the time given, a stick is placed in the ground about ten feet from the corner of the house exactly where the shadow falls.

The further steps are quite easy. A stout post from four to six inches square was placed firmly and as perpendicularly as possible by means of a plumb-bob (a bunch of keys served my purpose), and the top of the post was cut off an inch or two lower than the eye when standing upright. I think it would be better to make a little seat behind the post and then cut the latter accordingly. In this case, a post a yard and a half long in all would be sufficient, whereas mine was seven feet in length before insertion.

We now come to the improved sight, which is the really original part, upon which the superior accuracy of the whole contrivance depends.

A piece of tin about eight inches long by one-and-a-half inches wide was carefully cut out of a large mustard tin to the following shape :—

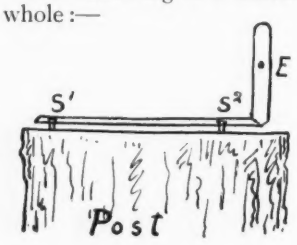


S^1 and S^2 are holes for screws. E is the eye-hole. The wider portion was bent at right angles to the strip at the dotted lines, and in front of the eye-hole was placed a slip of dark glass about one inch wide, the sides of the tin being turned over to keep it in position. The whole contrivance was then placed on the flat top of the post and fastened to it by one screw (S^1) only.

At the earliest date possible, resort was again had to the railway station for time, and at noon on the

XUM

same day the sighting apparatus was again adjusted as accurately as possible and the second screw put in place. The final error of this last setting was so extremely small that I never once moved the sight. If I remember rightly I decided that it was correct to within three seconds of time. The blue glass made the transit of the sun past the corner of the house quite easy to observe, and the first and last limbs could be taken with no difficulty. A second piece of glass might be useful for very bright days, but care must be taken that the corner of the house is visible. It is obvious that any other perpendicular object would serve the purpose if high enough. The glass requires a rub now and then. The eye-hole was perhaps one-sixteenth of an inch in diameter, and was rather too large if anything. The screw holes were, of course, made exactly to size. S^2 might be a slot for adjustment, but this is perhaps an unnecessary refinement. The following is a sketch of the side view of the whole:—



At the Manchester Reference Library is a mean time clock which is kept to correct time, and the error of which each day is noted on a card inside the clock case. Comparing my watch error, ascertained as above, I found I was seldom more than a second or two wrong. I am confident that if I had possessed a sidereal watch I might have got time quite accurately enough for setting an equatorial—using of course the Apparent Right Ascension at "Apparent" Noon from the Nautical Almanac instead of the calculations required above to obtain mean Greenwich time.

The whole apparatus might be fixed to the top of a wall or other object, as a post in the ground might easily move a little, however well set at first. The glasses should be carefully chosen so as to take away all glare from the sun and yet enable terrestrial objects to be seen at the same time. They should be cut into strips say three inches by one inch. The colour matters little. Blue glass of various degrees of opacity may be obtained ready cut at most opticians for twopence a piece. No cover or protection of any kind is required, but the tin portion should be painted with black enamel to keep it from rusting, and the glass may require an occasional rub up, and hence should slide easily into its place. The post must not be placed too far away from the house corner, or observation of the Midsummer sun will be impossible. The post ought to be at least two feet in the ground, and the hole should be dug as small as possible, so as to require little "ramming."

The cost of the whole was about a shilling, a sum surely not very prohibitive even in these hard times.

JULY SHOOTING STARS.

By W. F. DENNING, F.R.A.S.

THE meteoric observer invariably notices a very marked increase in the hourly number of visible shooting stars at about the middle of July. In previous months he may have recorded from about four to six per hour, but during the last half of July he registers fifteen or twenty per hour, and, indeed, he sometimes finds the fall of meteors so frequent that it is impossible to record them all with sufficient care and accuracy.

It is at this particular period of the year that the firmament becomes increasingly interesting to the observer. It not only supplies an abundance of materials, but they are of a highly entertaining nature. The Perseids commence their bombardment of our atmosphere, and display many bright specimens of the streak-leaving, swift type of meteor. The Aquarids are also in very numerous evidence, providing long-pathed meteors, with slow flights and yellow trains.

The Perseids have already been pretty thoroughly investigated. Their heights average from eighty miles at appearance to fifty miles at disappearance, and their velocity is nearly forty miles per second.

One of the chief observational features connected with this great July-August shower is the change in position of the radiant. On July 15th, the Meteors shoot from the point $15°+49\frac{1}{2}°$, on July 23rd the centre is at $23°+52°$, and on July 30th $30\frac{1}{2}°+54°$. When the shower first manifests itself the Meteors diverge from Cassiopeia and when it ends, in the third week in August, the radiant is in Camelopardalus.

The Aquarid shower is chiefly active between July 27th and 30th and the radiant point is apparently stationary at about $339°-11°$. There are a great number of other showers determinable by close and accurate observation. That the radiants may be exactly deduced it is required that the *directions of flight* of the Meteors be registered with the utmost attainable precision.

The chief facts requiring notice are the hourly number of Meteors and the positions of the radiant points on each night of observation. Moonlight will greatly interfere with a successful view of the principal streams during the last half of July this year, but with fine weather and the selection of suitable times a large amount of data may be secured.

Every Meteor as bright as, or brighter than, first magnitude should have its apparent path amongst the surrounding stars recorded, so that its real course may be computed in the event of duplicate observations having been obtained elsewhere.

THE LIFE HISTORY OF THE PEAT-MOSS

(*SPHAGNUM*).

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

Hartley University College, Southampton.

EVERYONE who has walked over our heaths and moorlands must have noticed the soft, spongy patches, often of large extent, formed by the Peat-Moss, or Bog-Moss, of which there are many species and varieties, differing in comparatively small details. As is well known, the power possessed by these mosses of absorbing large quantities of water, renders them useful in various ways, for instance in the cultivation of very many species of orchids and ferns.

If we pull up a handful of *Sphagnum* (see Figure 1) we note that the stems are individually limp and weak, but they gain support by their close aggregation. When growing, as is usual, in cushions above the surface of the water, the stems are upright, and the densely crowded branches at the top of each stem are either pale green or show various shades of red, yellow or brown. Lower down the plants are brownish or dirty white. The length to which the stems may grow is practically indefinite, and when the plants occur loosely in pools they may be several feet in length, and of a deep green colour. The branches arising from the main stem are of three kinds, without counting those that produce the reproductive organs—which will be dealt with later. In order to make out the arrangement of the branches let us examine closely the lower part of a plant, for at the top the branches are short and closely crowded, so as to form a compact rounded head. The branches are in tufts spaced out on the stem, usually one to every fourth stem-leaf, and each tuft consists of from three to eight (sometimes more) branches, of which some stand out from the stem, while others hang down close to the latter (see Figure 2); we may call the first kind the outstanding, or *divergent*, branches, the second the drooping, or *pendent*, branches, and it will be noticed that the latter are usually longer and more slender, and that they cover the stem as with a loose mantle. Here and there we find other branches, which, unlike the divergent and the pendent branches of the tuft, grow upwards, and themselves bear tufted branches, thus repeating the growth of the main stem. Apparently these branches, which continue the upward growth of the stem, are formed at long intervals, perhaps not even once a year. Experiments with plants kept in cultivation show that these branches of "unlimited" growth are simply outstanding branches whose growth continues, instead of soon coming to an end; for amputation of the stem below the terminal head of crowded branches often induces the development of a branch which grows upwards, and would probably have formed an ordinary short branch under normal conditions. It is owing to the formation of these erect secondary stems, each of which normally grows to the same height as the parent stem, that the whole plant undergoes repeated forking, and produces the characteristic rounded cushions. The crowding of the branches at the top of the plant to form the head, or "coma," is, of course, simply due to the fact that the stem "joints" (internodes) between the branch-tufts have not yet lengthened out in this, the youngest and most actively growing region of the shoot.

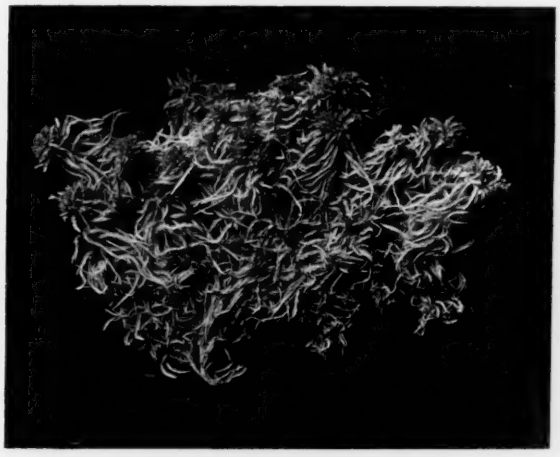


FIGURE 1.

A piece of *Sphagnum acutifolium*, natural size; only the upper portion of the plant is shown.

Microscopic examination shows that the stem, and each of its branches, grows by means of a pyramid-like apical cell, from which cells are cut off in spiral succession from the three flat sides, the apical cell growing in size after each cell or segment is cut from it (see Figure 3). Hence the youngest leaves are arranged in three rows, but, by displacement during their later growth, the leaves come to be arranged in (usually) five rows on the stem (see Figure 4). Each leaf for a time grows by a two-sided cell at its tip, from which new cells are cut off, in an extremely regular manner (see Figure 5), to right and left alternately. The young leaf bears at its base a number of club-shaped gum-secreting hairs, each consisting of a large egg-shaped end-cell supported on a short row of smaller cells (see Figure 3); these hairs serve to protect the delicate tissue of the young

XUM

leaf, and they soon disappear as the leaf grows. The cells of the leaf are at first quite uniform in size and shape (see Figure 6), and all contain protoplasm and chlorophyll-grains, but they soon become differentiated into two sets. Some of the cells remain narrow but grow greatly in length, and are arranged so as to form a network, with diamond-shaped meshes, each mesh being occupied by a cell which grows in breadth as well as in length. The narrow cells retain their original contents and are therefore living green cells, but the large cells lose their contents and are dead and colourless. The differentiation of the two kinds of cells takes place in a curiously regular fashion, as can easily be traced on examining developing leaves of different ages. Each cell of the young leaf divides eventually in such a way as to cut off a cell which is directed to the tip of the leaf and one which faces either the right or left side of the leaf; this is shown diagrammatically in Figure 7, where the dotted line represents the central axis of the leaf. The cells facing the apex (A) and the sides (R, L) of the leaf remain narrow, while the third cell (H) of the triad grows in all directions, and forms one of the large hyaline cells (see Figure 8). As each cell divides up in this symmetrical manner we get a regular and beautiful network of narrow green cells enclosing the large hyaline cells (see Figure 9). The latter have their walls thickened by bars deposited on the inner surface of the wall (at the expense of the protoplasm which is used up in the process); these thickenings are often ring-shaped, and are sometimes joined up in various patterns, and they serve to strengthen the cell. As we might expect, these fibres are thickest in the cells of the outstanding branches, and their thickness varies considerably, according to the habitat in which the plant grows. For instance they are strongly developed in plants growing in exposed or sunny places, while they are feebly marked in plants growing in shade, or in very wet positions, and in submerged plants they may be absent altogether — in these submerged plants, in fact, the tissue of the leaf often remains quite uniform, all the cells containing chlorophyll, and being of the same form and size. In the leaves borne on the main stem, which are soon covered up by the pendent branches, and therefore become functionless, the green cells soon lose their chlorophyll, while the walls of the hyaline cells become perforated with holes of irregular size and outline. In the branch-leaves the hyaline cells have their walls perforated to a smaller extent and in a more regular fashion, the pores being circular or oval, and having a thickened rim (see Figure 9). These pores generally occur at the points where three cells meet, though they are also found along the sides of the

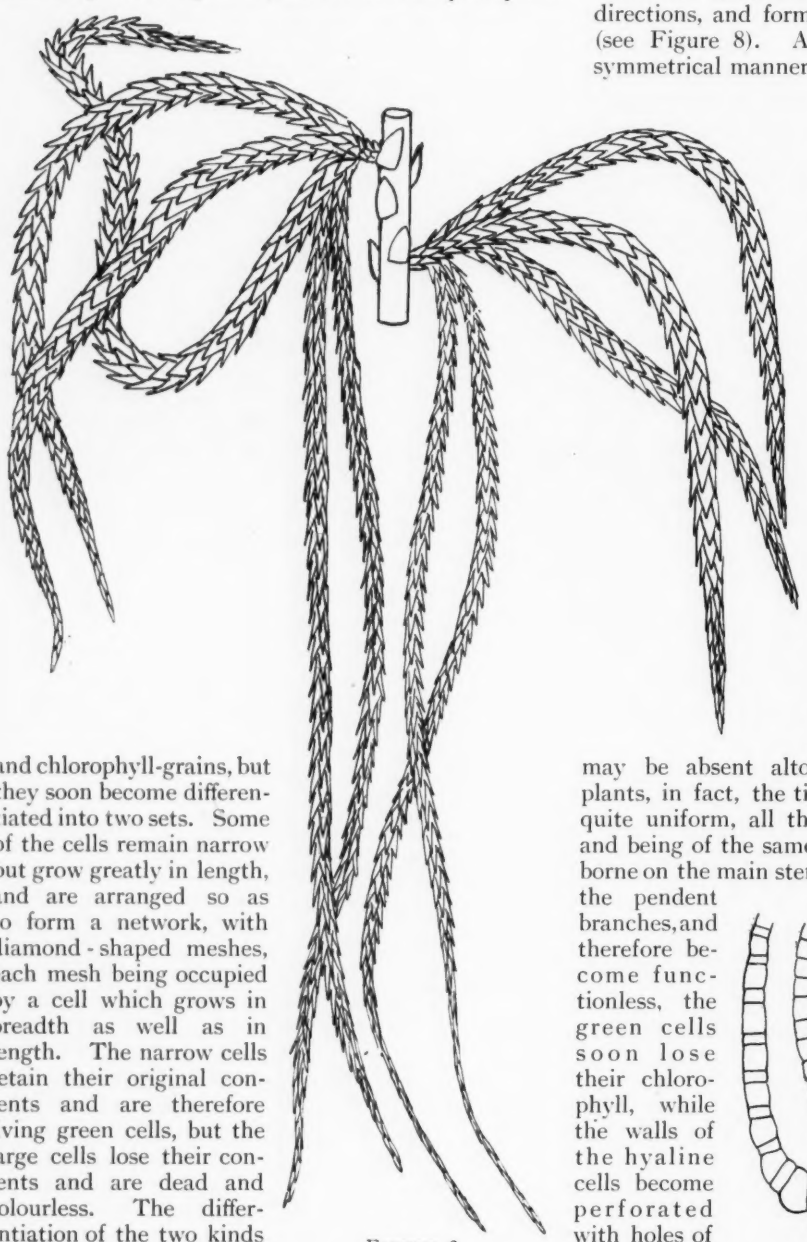


FIGURE 2.
Lower portion of a stem of *Sphagnum* enlarged, showing two tufts of branches; each tuft consists of three divergent and two pendent branches.

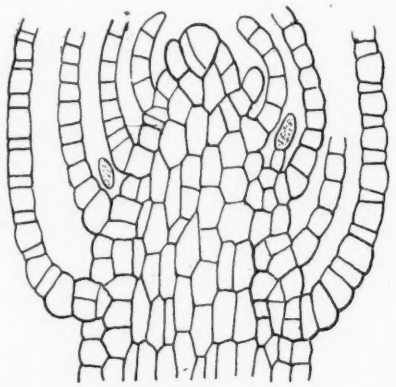


FIGURE 3.
Longitudinal section through the growing apex of a *Sphagnum* stem, showing the apical cell and the young leaves.

hyaline cells, where these border on the green cells.

At first a section across a young leaf (see Figure 4) shows that the cells, arranged in a single layer, are all square and of about the same size, but as the leaf developes we find on cross section an alternation of hyaline and green cells, the former being the larger (see Figure 10). In some species of *Sphagnum* the hyaline cells bulge towards the underside of the leaf, the green cells being then triangular in cross-section, having the base of the triangle directed upwards, and about flush with the upper side of the leaf. In other species the relation between the two kinds of cells is just the reverse of this; while in others, again, the green cells are hemmed in, both above and below, by the hyaline cells, and may appear in section as spindles, whose ends reach neither the upper nor under side of the leaf. The classification of the genus—an extremely difficult and much-debated subject—is largely based on the appearance of the two kinds of leaf-cell as seen in cross-section.

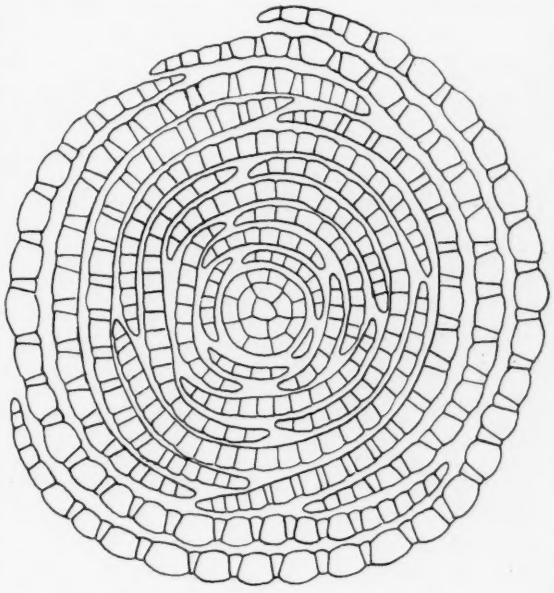


FIGURE 4.

Cross-section through the growing tip of a *Sphagnum* branch, showing the apical cell (in centre of section) and the developing leaves.

The leaf of a Peat-Moss is remarkably well adapted for the absorption of water, which enters by the pores into the large empty cells. When wet the plant appears green, but when dried it becomes whitish, the green colour due to the narrow cells being lost to view owing to the reflection of the air which has replaced the water in the empty cells.

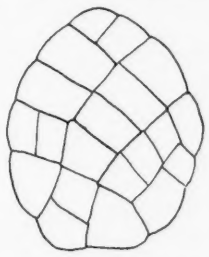


FIGURE 5.

A very young leaf of *Sphagnum*, magnified.

The thickening fibres, which have the form of bands projecting into the cavity of the hyaline cells, prevent the cells from collapsing when empty. It would be difficult to find an equally simple and efficient example of division of labour as that presented by the *Sphagnum* leaf, with its network of linked-up green food-making cells, and its isolated and strengthened porous water-storing cells. But before discussing the biology of our plant let us examine the minute structure of its stems and branches.

The inner tissue of a main stem consists of long cells rather sharply marked off from an outer zone of short rind-cells (see Figure 11). The rind, or cortex, is at first a single layer, and in the branches it remains one cell thick, as a rule, but in the main stem it often becomes four layers deep (see Figure 12), its cells being large and colourless in most species. In plants growing submerged in pools the whole stem consists of practically uniform tissue, all the cells except the innermost having chlorophyll—that is, in such plants the stem tissue undergoes no differentiation, and remains in the early stage, which is soon passed through in plants growing out of the water. In some of the species, the cells of the rind resemble the hyaline cells of the leaf in having strengthening fibres and pores on their walls (see Figures 13 and 14), but in most species these cells are devoid of fibres and pores.

The tissue within the cortex is differentiated, though not with sharp limits, into an outer zone of narrow thick-walled cells and a central region in which the cells are wider and have thinner walls; in the outer zone the long narrow cells show pits on their walls, but as growth proceeds the walls become uniformly and strongly thickened, and at the same time tinged deep brown. Hence we get a tubular band of strong tissue, which, in the fully-developed portions of the stem, serves a purely mechanical supporting function, and makes the stem wiry and fairly rigid. Evidently the pits are only of service—placing the cells in communication with each other and helping in the conduction of food-materials—while the cells are young and growing. In the branches, of both the outstanding and drooping types, some of the cells of the single-layered rind grow large, and have their wall perforated at the upper end by a circular or oval hole, and, as this end usually projects outwards, these cells acquire a quaint appearance, somewhat like a bottle with a curved neck. These curious water-bottles, or "retort cells," are shown in Figures 15 and 16—they do not occur in those species in which the cortex of stems

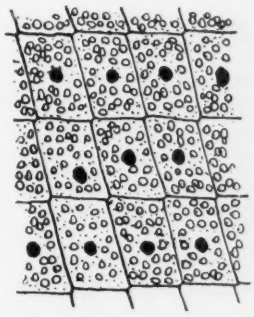


FIGURE 6.

Part of a young leaf of *Sphagnum* before differentiation of the cells has begun; magnified.

and branches consists of perforated fibrous cells.

From what we have learned as to the structure of the Peat-Moss, we can readily understand how these plants are able to store up such large quantities of water, which, when the plants are saturated, fills the cortex of the stem, the retort-cells of the branches, and the porous hyaline cells which make up such a large proportion of the leaves. A lump of air-dried *Sphagnum* was weighed and then placed in a dish of water; after draining off the water which merely adhered to the surface of the mass, it was found that the plants had absorbed nearly twenty times their weight of water. Other experiments showed that the air-dried plants could also absorb a relatively small amount of water vapour from saturated air; the proportion thus taken up, however, was only about a quarter of the dry-weight of the plant—no more than can be absorbed in this way by many other dried Mosses. The amount of water evaporated from a patch of *Sphagnum* was found to be about five times as much as that lost from an equal surface area of water. The Peat-Mosses, therefore, have an extraordinary capacity, unequalled by any other plants, of absorbing and giving off water. The rate at which water is absorbed and evaporated is the same in dead as in living plants; hence the process is a purely physical one. If either the upper or the lower end of a shoot is dipped into water, the whole plant becomes wet in a short time, and eventually saturated; if the water is coloured, its passage upwards can readily be traced. Does the water pass up in the tissue of the stem itself, or does it creep along the surface? In most species of *Sphagnum*, it is easy to prove that the water is drawn up by capillary action, and that the capillary spaces are formed by the drooping branches which hang down against the stem, overlapping each other and forming a most effective system of capillary tubes; for if the tufts of branches be removed from the end of the stem, which is then dipped into water, the plant remains dry. But in a few species (*S. cymbifolium* and its allies), in which the cortex cells have pores and fibres on their walls, the removal of the pendent branches does not stop the upward flow of water, though even here water passes up much more rapidly when these branches are left intact; in these species no water ascends at all when both the pendent branches and the cortex are stripped off from the end of the stem. In all cases we may regard the whole *Sphagnum* plant as an elaborate system of capillary tubes, formed by the drooping stem-branches and by the porous leaf-cells, plus a relatively small amount of green living tissue consisting of the network of narrow cells in the leaves. In those species which regularly grow submerged in water, all the branches spread out from the stem, since there is no necessity for a water current, and if one of the ordinary species is cultivated under water, the new branches formed are all of the divergent type.

The Peat-Mosses rarely grow on limestone, or on soils containing a large proportion of lime, but their avoidance of lime appears to be due to the fact that limestone does not afford the impervious substratum which the plants require, for they grow well enough when cultivated in water containing a large proportion of lime salts. In the tropics these Mosses are confined to the higher mountains, and there is one species in Florida which has an unusual habitat, growing on the trunks of trees. The Peat-Mosses are not well adapted for withstanding prolonged drought, differing in this respect from the majority of other Mosses.

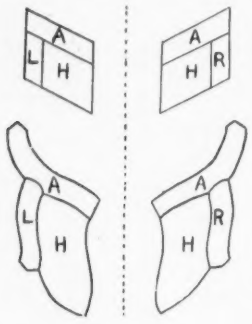


FIGURE 7.

Diagram to show the division of the leaf cells into triads; see text.

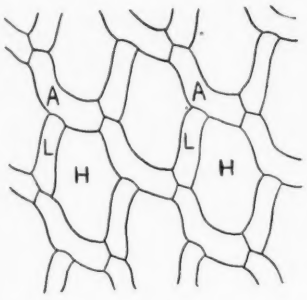


FIGURE 8.

Part of a developing leaf, magnified; see description in text.

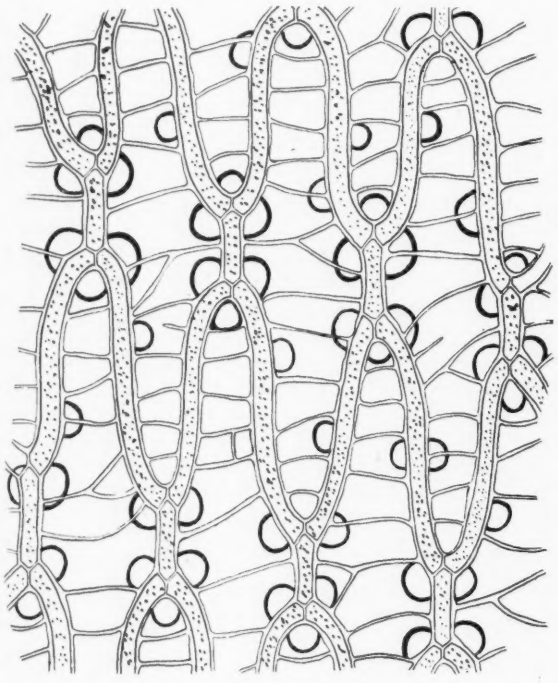


FIGURE 9.

Part of a mature *Sphagnum* leaf, showing the larger water-cells and the network of narrow green cells.

The biology of *Sphagnum* has received various interpretations, but it seems most probable that their astonishing faculty for drawing up and evaporating immense quantities of water is connected with the poverty of the substratum as regards mineral salts required for the growth of these plants. In this connection, a broad distinction may be drawn between a marsh and a bog, though there are, of course, transitions between the two. The typical marsh occurs on low ground; its water is rich in mineral substances, especially lime, and its plants grow rapidly, either becoming tall, or else remaining low, but producing numerous leaves and branches each year. In the typical bog the water is poor in lime and other salts, and the plants are mostly slow-growing and of low stature. The soil of a bog is not sufficiently aërated for the proper formation of nitrates, and although peaty soils often appear on analysis as though they should be extremely fertile, very little of the material that they contain is directly available to serve as plant food. Hence the Peat-Mosses must absorb and evaporate large quantities of water in order to obtain the salts necessary for their growth, and as they excel all other plants in the perfect capillary mechanism which they possess for this purpose they often form the dominant vegetation in the wetter portions of bogs, especially when over-lying an impervious soil.

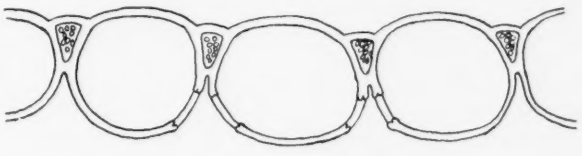


FIGURE 10.

Cross-section of a *Sphagnum* leaf.

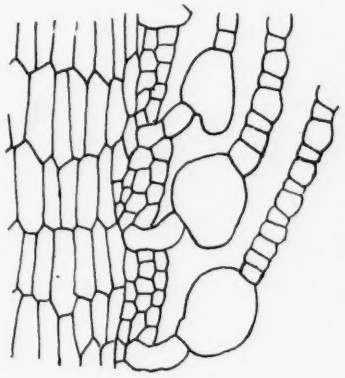


FIGURE 11.

Part of a longitudinal section of *Sphagnum* plant, taken a short distance behind the growing apex.

As the plants branch and grow upwards, the lower parts die off, but they undergo only partial decay, since they are protected against the action of bacteria by means of an antiseptic substance, named "sphagnol" from its abundance in the tissues of the Peat-Mosses. The upward growth of the plants is continued year by year, but it is seldom possible to trace a single stem to any great depth, owing to the brittleness of the older portions. Owing to their long-continued growth, the plants, when growing luxuriantly, may give rise to considerable masses of partially decomposed matter, or peat, but peat is not always formed from *Sphagnum*. The peat deposits covering the moors of this country are chiefly produced by the Cotton Sedge (*Eriophorum*), and on the moors of Yorkshire and Devonshire, for instance, *Sphagnum* rarely occurs in large masses, but is found chiefly in the wetter pockets or depressions. However, extensive *Sphagnum* bogs, with deep peat composed largely of the remains of these plants, are found in various parts of Britain, especially in Ireland. The Peat-Mosses, along with other bog plants, frequently cause the filling up of pools and the drainage of stagnant waters, converting them into comparatively firm soil, in which even trees may ultimately grow, so that they play an important part as pioneers in the colonising advance of amphibious and land plants upon areas previously occupied by aquatic plants. They thus perform useful work in the reclaiming of areas which would otherwise remain as watery wastes. This useful work, however, results eventually in the destruction of the Peat-Mosses themselves, since they die out when they have drained the water underlying them, unless the moisture which they draw up and evaporate is replenished by a high rainfall. Hence, in cuttings made in old and deep peat deposits, the lower portions of the peat are often found to consist chiefly of *Sphagnum* remains, in localities where *Sphagnum* no longer covers the surface, either being absent altogether or confined to the pools and wet hollows.

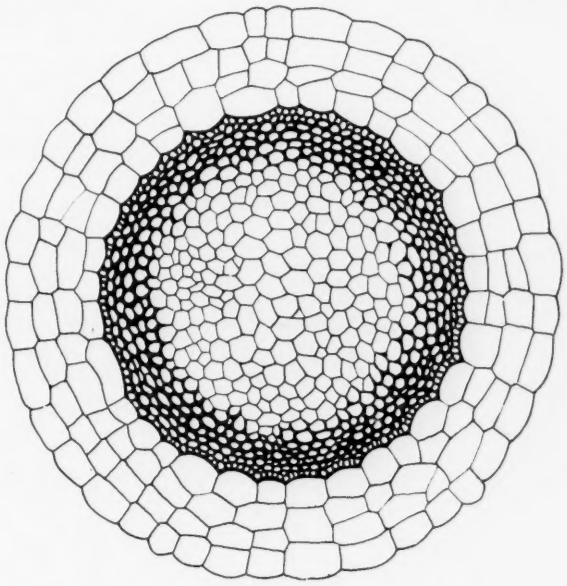


FIGURE 12.

Cross-section of the stem of *Sphagnum acutifolium*.

At times, the Peat-Mosses cause serious mishaps, owing to the bursting of the bogs, the spongy *Sphagnum* beds absorbing an unusually heavy rain-

fall and overflowing on to the lower ground. In 1883, after a heavy rain, several thousand acres near Castlerea were submerged in this way, mills being stopped, bridges choked, roads blocked up, and fields covered to the depth of over twenty feet by the dark lava-like liquid peat. In other cases, cottages and farms have been buried in the same way, and the treacherous *Sphagnum* bogs have often swallowed up cattle and human beings who incautiously ventured to cross them.

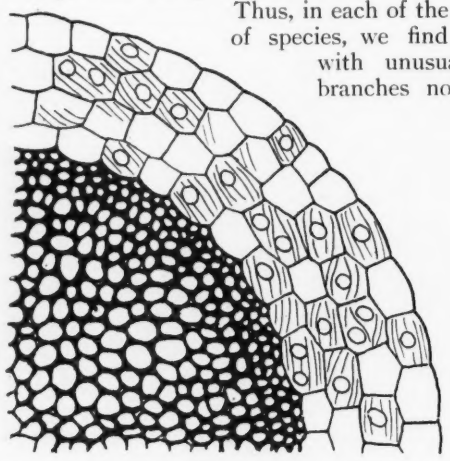


FIGURE 13.

Cross-section of the stem of *Sphagnum cymbifolium*.

When we study the reproduction of *Sphagnum*, we find that the organs concerned are absolutely uniform in all the species and varieties of the genus. Hence the classification of *Sphagnum* depends entirely upon the vegetative organs, and it is at any rate easy to divide the genus into a small number of natural groups, but beyond this point there is no general agreement among botanists as to what constitutes a species and what a sub-species or variety of *Sphagnum*. The variations observed may be attributed largely to differences in the conditions of the environment with regard to moisture, light, temperature, and soil. Thus, in each of the well-marked sections, or groups of species, we find forms which are submerged, with unusually long stems, the terminal branches not clustered into a head, but separated owing to active growth of the stem, the leaves longer and of uniform structure; forms growing in dry or cold habitats, in which the plants are compact, forming low tufts with short branches and closely overlapping leaves; and forms growing in shaded places, which are robust, with broad leaves, and deep green in colour. However, the classification of this well-marked and extremely isolated genus, which should perhaps be removed from the true Mosses and placed in a class by itself, has in recent years been brought into better order, though the determination of the species, sub-species, and forms is very often a difficult matter.

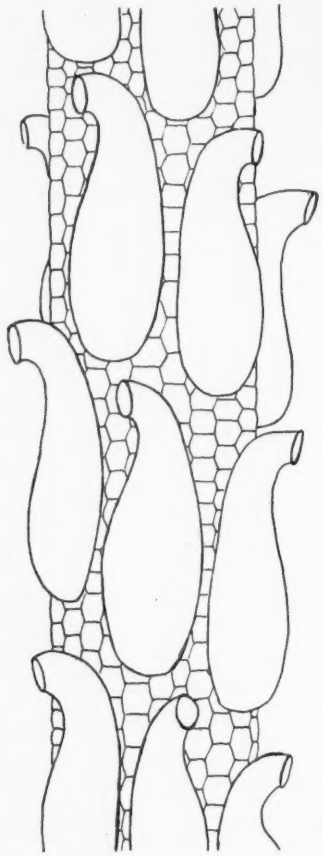


FIGURE 15.

Part of a branch of *Sphagnum molluscum*, after removal of the leaves, to show the "retort-cells" of the cortex.

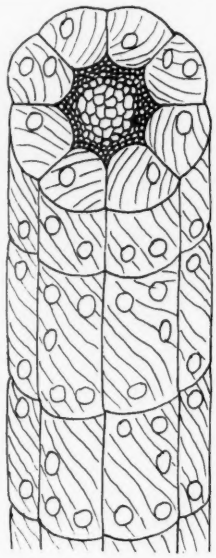


FIGURE 14.

Part of a branch of *Sphagnum cymbifolium*, the leaves have been removed to show the large cortex-cells with their fibres and pores.

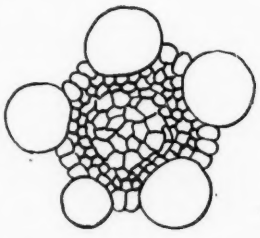


FIGURE 16.

Cross-section of a branch like that shewn in longitudinal section in Figure 8, the large "retort-cells" are cut transversely.

(To be continued.)

[NOTE.—*Professor Cavers would be very glad if any of our readers who are interested in the Mosses would communicate with him at Hartley University College, Southampton, as he would be prepared after he has completed his account of the structure of Bog-mosses, to write a third article dealing with the classification and ecology of the species of Sphagnum.*—EDS.]

THE EFFECT OF THE MOON UPON THE WEATHER.

By W. W. STRICKLAND.

I ADMIT myself incorrigible in the matter of the dogmatism of the official meteorologists in this respect—that is to say I hold that the negative they think they have proved is not proven. I do not say positively that the moon influences the weather; what I maintain is (1) The negative dogma is not demonstrated, and (2) That practically I have found, more particularly in certain regions and at certain seasons, that I can predict the weather with greater accuracy if I take into account the age of the moon, as well as the barometric pressure and the movement and position of the cyclones and the anticyclones, than when the first factor is ignored. I would, first of all, observe that according to my experience the effect of the moon upon the weather is not the same all over the world, or all over the year, and again, it may be greater at one season in one place and at another in another. Thus, for example, the effect of the moon is strongest during the winter in England. In Australia it seems to act all the year round pretty equally, while in Ceylon and the Malay States its effect is very slight, or nil. In Central Europe, in the neighbourhood of the snow-clad Alps, the effect is completely masked, though it cannot be absent altogether.

Travellers are aware that in Equatorial regions differences of atmospheric pressure, which, for that matter, are slighter than elsewhere, have not much value for predicting the weather. Before giving my own ideas in the matter I will briefly summarise the negative arguments of the official meteorologists.

(1) Comparing weather curves and statistics with the nearly constant curve for the lunar phases, no sort of connection can be detected between the two.

(2) If the moon affects the weather it ought to have the same effect everywhere.

(3) The moon only influences the upper stratum of the atmosphere, just as it only produces a superficial tide in the ocean.

As to (1) I wish to point out that the meteorologists have always insisted upon a constant and invariable connection between the phases of the moon and the weather, which, in my view of the matter, is practically impossible.

For example, they argue: Now it is cloudless at the full moon, now it is torrential; therefore no lunar influence.

On the other hand, Nasmyth, in his well-known work on the moon, believes that he has demonstrated that as a rule at the full moon the sky is clearer than at the quarters. I neither accept nor reject his theory. If, however, we do accept it, it is easy to see that the total effect will be very different according to the season and the locality. For example, suppose we are in the Prealpine region in summer after a snowy winter. The fields of snow will be much more extended than after a winter during which but little snow fell, so that if the full moon produces cloudless weather about Midsummer, the powerful sun of those latitudes will melt much more snow than would have been the case if very little snow had fallen during the winter. Consequently the evaporation, with its resulting cumuli, will rapidly conclude with rain and thunderstorms.

Therefore, in such localities the clearing effect of the full moon is almost entirely masked.

Just the opposite occurs in Australia, particularly in the drier zones of it, where no snow mountains exist, if we except Monte Kosciusko (7-8000 feet) in the folds of which a few patches of snow may, perhaps, exist through the Australian summer. And this explains why Mr. Wragge, a meteorologist of some repute, was himself extremely sceptical about the lunar dogmatism of our official meteorologists. Mr. Wragge has unhappily been deprived of his post, ostensibly for motives of economy; so that his Australian observations and nascent unorthodoxy have been nipped in the bud; but, more recently, another Australian meteorologist claims to have detected a nineteen years weather cyclus, which must necessarily correspond to the lunar one. However this may be, in England, indirectly in consequence of the spring tides, the moon can be observed to affect the weather even in summer, and still more markedly during a hard winter.

For example, if at Peterborough, on the river Nen, we have two or three inches of ice as far as the tide reaches inland, and a thaw and spring tide come together, the spring tide will break up the crust of ice and the river will overflow. In that case, if the frost recommence, it cannot repair the injury. The river and many similar ones, all round the coast of the small island, will remain open, overflow, and warm, more or less extensively, the superficies of the circumjacent territory. If, on the other hand, the thaw and the neap tides come together, the latter will not have force enough to break up the crust of ice on the tidal rivers, the rivers will remain covered, will not overflow, and when the frost again sets in it will easily repair the injury. In this case the ice may continue at least another week, that is to say, at least until the next spring tides.

As to Equatorial regions: these are, par excellence, solar regions, and it is not to be wondered at, if the lunar influence exist at all there, that it is reduced to a minimum.

XUM

(2) This negative argument appears to me extremely illogical, seeing that in certain localities the Moon produces an immense rise and fall of the tide, *e.g.* in the Bay of Fundy, where it is about thirty-seven feet, whereas in the Mediterranean it is scarcely perceptible.

The previous remarks partly explain why the effect of the Moon upon the weather, if it exist, cannot possibly be the same all over the world. As to the tide in the Mediterranean it is very sensible in the Quarnero, almost imperceptible at Genova. Are we then to assume that because it is not perceptible at the latter place as a rise and fall, that, therefore, the Moon has no effect at Genova and a very marked one at the Quarnero?

However this may be, in cold regions there is an indirect influence of the Moon, in winter, upon the weather in certain localities through the medium of the tide in tidal rivers.

But the tidal action of the moon is three-fold: Firstly Terrestrial, secondly Oceanic, and thirdly producing an effect which, if not perceptible, is certainly not on that account nil, upon the great body of water scattered above and below the surface of the earth.

Inasmuch as the weather depends chiefly or entirely upon the relative distribution and movements of the cyclones and anticyclones, any direct effect of the Moon upon the weather ought to consist in some sort of action upon these bodies. Moreover, since the systems of cyclones and anti-cyclones and their relative positions are different in different parts of the world, the effect of the Moon upon the weather cannot but vary in different regions and at different times. For instance, if the Moon accelerate or retard cyclones and anti-cyclones, or tend to flatten or intensify them, its effect will vary at a given place, according as a cyclone or anti-cyclone covers it, or is in its neighbourhood.

(3) It is stated that if the moon has any influence upon the atmospheric ocean it will produce tides at the top of it, but leave the lower strata intact. This is an argument which seems to me a very unconvincing one. Air is extremely compressible, water very much the reverse, and the mass of the air is much greater below than above: soon a point is reached where its pressure raises the column of mercury only a few inches in the tube. Under these circumstances, seeing that the moon admittedly raises a tide in the sea, how can it affect the rarefied air at the top of the air-ocean, and leave the much heavier air at the bottom of it quite unaffected?

In attempting to point out some of the difficulties in the way of accepting off-hand the negative dogmas of the official meteorologist as regards the moon and the weather, I have also shown how the moon may be reasonably supposed to affect the weather. My attitude towards the subject is, however, a purely sceptical one. The absence of any connection between the weather and the moon seems to me as little demonstrated as to the distinguished Flammarion the presence of one between sun spots and magnetic storms, although to some the coincidences between the curves of the two phenomena appear to prove the same to demonstration. A few years ago our scientific big-wigs had proved human aviation to be impossible and the atom indivisible; now we have ions and electrons, and, quite a number of men have flown.

KEW AND ESKDALE MUIR OBSERVATORIES AND THE METEOROLOGICAL OFFICE.

By arrangements recently concluded between the Lords Commissioners of H.M. Treasury, the Royal Society, the National Physical Laboratory, and the Meteorological Office, the administration of the work of the Kew Observatory, in so far as it is concerned with observational and experimental work in meteorology and geophysics, will be transferred to the Meteorological Office as from 1st July, 1910. The Kew Observatory will be the Central Observatory for the Office. All communications respecting that side of the work of the Observatory should thenceforth be addressed to the Director of the Meteorological Office, Kew Observatory, Richmond, Surrey.

By another provision of the arrangement, the administration of the Observatory at Eskdale Muir will be associated by the Royal Society with the Meteorological Office, instead of, as heretofore, with the National Physical Laboratory.

In the conduct of the administration of the Observatories, the Director of the Meteorological Office will have the assistance of an advisory Committee—the Gassiot Committee, appointed by the Royal Society to administer the funds of the Gassiot Trust, representing an endowment of £10,000 vested in the Royal Society, in 1871, by Mr. J. P. Gassiot.

One of the provisions of the new scheme is that the Superintendents of the three Observatories—Kew, Eskdale Muir and Valencia—under the direction of the Meteorological Office—shall be appointed by the Meteorological Committee upon the nomination of the Gassiot Committee. On this nomination the appointments of Dr. C. Chree, F.R.S., as Superintendent of the Central Observatory, and of Mr. G. W. Walker, M.A., of Eskdale Muir Observatory, have been continued by the Meteorological Committee. Dr. Chree has further been appointed Assistant-Director of Observatories for the Meteorological Office. Mr. J. E. Cullum remains Superintendent of Valencia Observatory.

The work of testing instruments now carried on at Kew Observatory by the National Physical Laboratory will be removed to Teddington as soon as the necessary provision for its transference can be made. The Laboratory will retain the well-known K.O. mark for use with those classes of instruments which have hitherto been tested at the Observatory. For the time being the work will be carried on at the Observatory as a department separate from the observational work, but under the superintendence of Dr. Chree.

Communications respecting this side of the work should in future be addressed to the Director of the National Physical Laboratory, Observatory Department, Richmond, Surrey.

XUM

ASYMMETRY IN BIRDS.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U.

British Museum (Natural History).

ASYMMETRY among the vertebrates is rarely met with: the flat-fishes among the fishes, and the skull in the Cetacea afford the most striking examples of this phenomenon. Among the lower vertebrates—in Amphioxus—we find asymmetry in the larva, but elsewhere it is a character of adult life, increasing with age.

Among birds, two peculiarly interesting instances are found. The one is furnished by the Wry-billed Plover, *Anarhynchus frontalis*, the other by the Owls.

In the first-named, it will be remembered that the beak, from its middle onwards, turns sharply to one side—the right. And this, apparently, to enable the bird the more efficiently to drag out prey from under stones.

The Owls afford far more striking instances, but withal yielding no clue as to their significance. Briefly, among these birds a number of species are asymmetrical in regard to the aperture of the ear. Usually in birds the external opening of the ear takes the form of a small, round hole, below and behind the eye, and behind the proximal end of the mandible. Among the Owls a typical aperture, such as this, is met with only in the genera *Athene* and *Speotyto*. In the Genera *Bubo* and *Scops* we find the earlier stages of a new departure wherein this aperture increases in size, and developes, in many cases, a strange asymmetry on the two sides of the head. In this increase the first change is the assumption of an oval shape: later, as in *Ninox*, and still more, it may be pointed out, in *Scops*, the aperture increases so much as to expose the surface of the sclerotic plates encircling the eye-ball.

In *Syrnium*, e.g., Tawny Owl, a still further increase in the size of this opening is seen, a large portion of the parietal region of the skull, as well as the eyeball, being exposed. And here we meet with the first marked instance of asymmetry, the aperture of right ear being much larger than that of the left. Furthermore, a new structure has appeared—the "operculum." This takes the form of an oval flap of skin formed by the extension backwards of the anterior margin of the membranous aperture, which thus serves as a lid, or as a hinged door, closing the aperture at will. The actual passage to the ear lies at the lower, and hinder segment of the semi-circular opening thus formed.

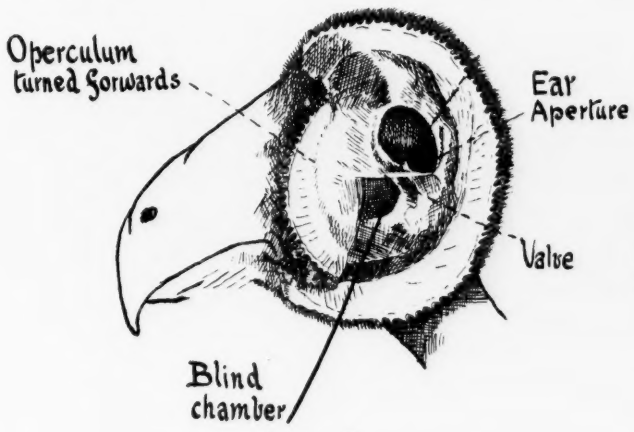


FIGURE 1.
Head of the Short-eared Owl, left side.

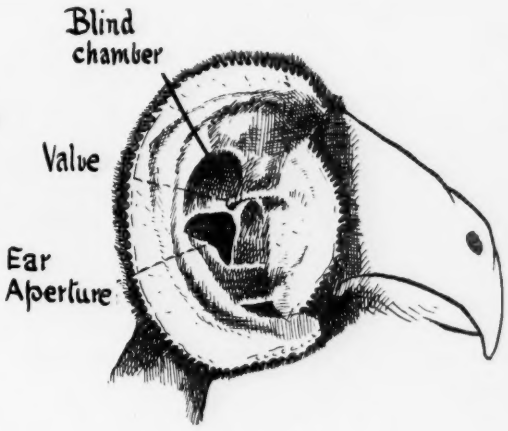


FIGURE 2.
Head of the Short-eared Owl, right side.

The Long and Short-eared Owls, of the Genus *Asio* have, so to speak, carried this model to its farthest limits, since the opening extends downwards and forwards to the gape, and upwards and forwards to a point above the middle of the eye, exposing the whole side of the skull, and sclerotic region of the eye. The aperture is symmetrical in regard to size, and the operculum is proportionately large. The asymmetry here is formed by the presence of what I have elsewhere called a "valve," which extends, in the form of a sheet of membrane, from the operculum backwards, across the middle of the aperture, to the parietal wing of the skull. On the right side of the head there is found, above the valve, a blind and shallow chamber, while below it, above the hinder end of the lower jaw, is a large cavity—the entrance to the ear. On the left side of the head these conditions are reversed—the entrance to the ear is *above* the valve, and the blind chamber below it. These Owls, as we have hinted, present an excessive development of

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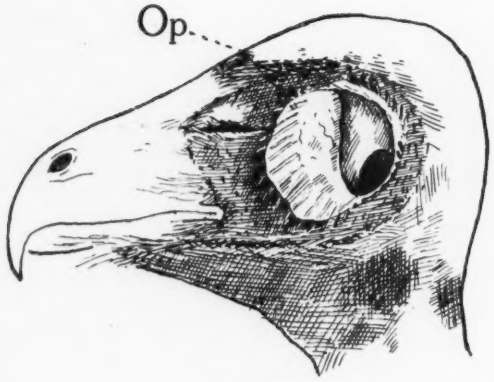

FIGURE 3.

Head of Tawny Owl, left side. Op. operculum.

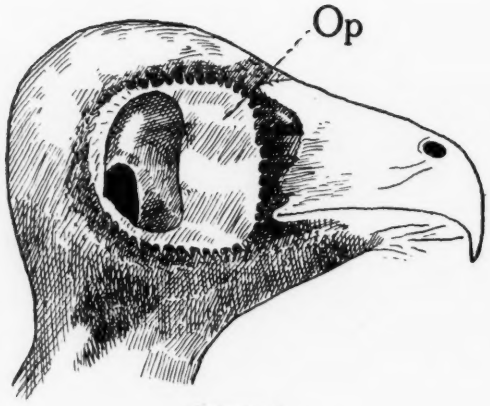

FIGURE 4.

Head of Tawny Owl, right side. Op. operculum.

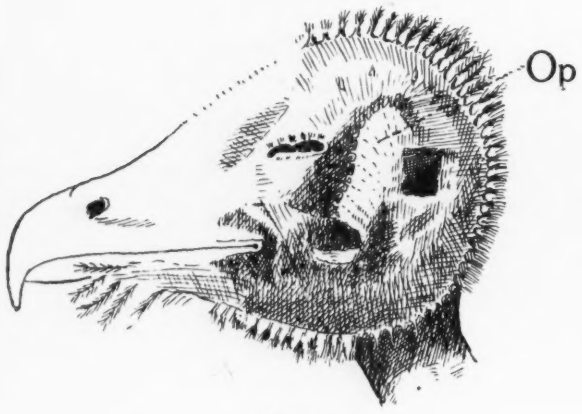

FIGURE 5.

Head of Barn Owl, left side. Op. operculum.

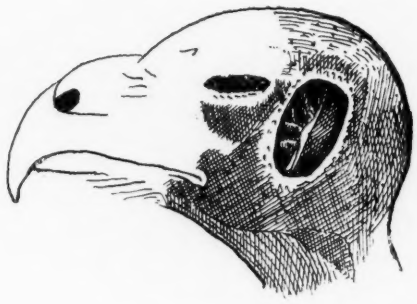

FIGURE 6.

Head of Scops Owl, left side.

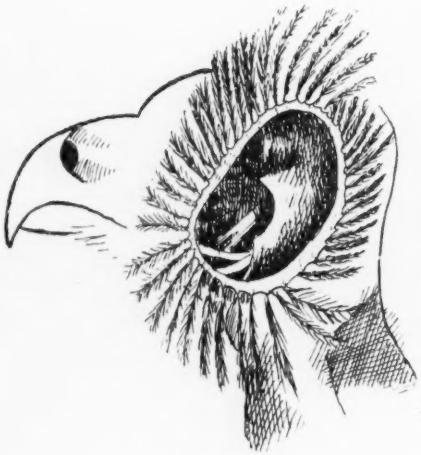

FIGURE 7.

Head of Tengmalm's Owl, left side.

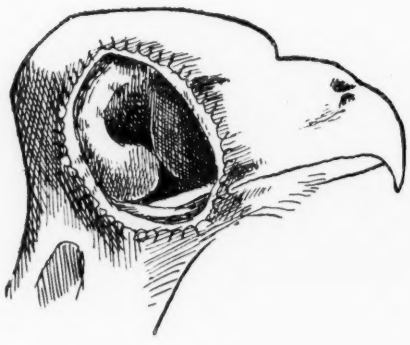

FIGURE 8.

Head of Tengmalm's Owl, right side.

Figures 1 to 8 are taken from *A History of Birds*, by permission of Messrs. Methuen & Co., Ltd.

what obtains with the Tawny Owls. The Barn Owl, and that aberrant type the *Photodilus*, display modifications in a way intermediate in character. In the Barn Owl the aperture is quadrangular in shape, and is protected by an operculum much larger than the aperture it covers: but there seems to be no asymmetry. *Photodilus* in many respects recalls the Barn Owls, in others the Tawny Owls. But there is no operculum, and the aperture, on each side of the head opens into a deep groove. But that of the left side is markedly higher up than that on the right: moreover, the groove on the right side of the head forms a deep fossa above the aperture, and a shallow diverticulum beneath it: on the other, the left side, the reverse is the case, the deep fossa lying beneath and in front of the aperture. On the right side of the head, it may further be noticed, is a small shelf of skin forming the roof of the auditory opening, and this may well answer to the "valve" described in *Asio*. In both *Photodilus*, and *Asio*, it will be remarked, the relation of the apertures to the blind diverticula is the same—on the left side the diverticulum is above, and on the right side below the aperture. In *Photodilus*, however, the aperture is, actually, not relatively, higher up than in *Asio*.

Now, so far, all the modifications described have been superficial. That is to say they have not affected the skull. But in Tengmalm's Owl (*Nyctaea*) the skull itself has undergone a profound change in regard to the development of the bony wings known as the post-orbital process and lateral temporal wing. For on the right side of the skull this temporal wing forms a tongue-shaped plate turned forwards to touch the sclerotic rim of the eye and the post-orbital process, while on the left side this wing is deeply notched, and touches neither the eye nor the post-orbital process. The membranous aperture, it may be remarked, is enormous.

So far, no explanation of these strange modifications seems to be possible. Presumably they are associated with the collection of sound, and they have certainly markedly affected the appearance of these birds, for thereto is due the characteristic Owl physiognomy.

In the Long and Short-Eared Owls the skin forming the semi-circular posterior wall of the auditory aperture is drawn out into a wide fold, or curtain, the free-edge of which bears a number of long, narrow, closely-set feathers, vastly increasing the width of the curtain, and forming the segment of a trumpet-mouth—effecting the same purpose as is achieved by the human hand when applied behind the ear to catch sounds, as with people hard of hearing. Similar feathers are found in the Barn Owl, but these are set in a low ridge of skin, closely fitting the skull. But when we have remarked this, nothing more remains to be said, for in watching live Owls no movement of the operculum, or of these "peripheral disc-feathers" can be detected. It seems obvious enough that the formation of such an "ear-trumpet" must be useful to crepuscular birds feeding on active prey, but no explanation of the asymmetry herein described seems possible. Perchance a closer observation of birds in captivity may lead to a solution of the problem. Embryology offers no aid. But it is significant to note that in the embryo of the Long-eared Owl this aperture, at one stage of its development, exactly corresponds to the adult stage that is seen in *Scops*.

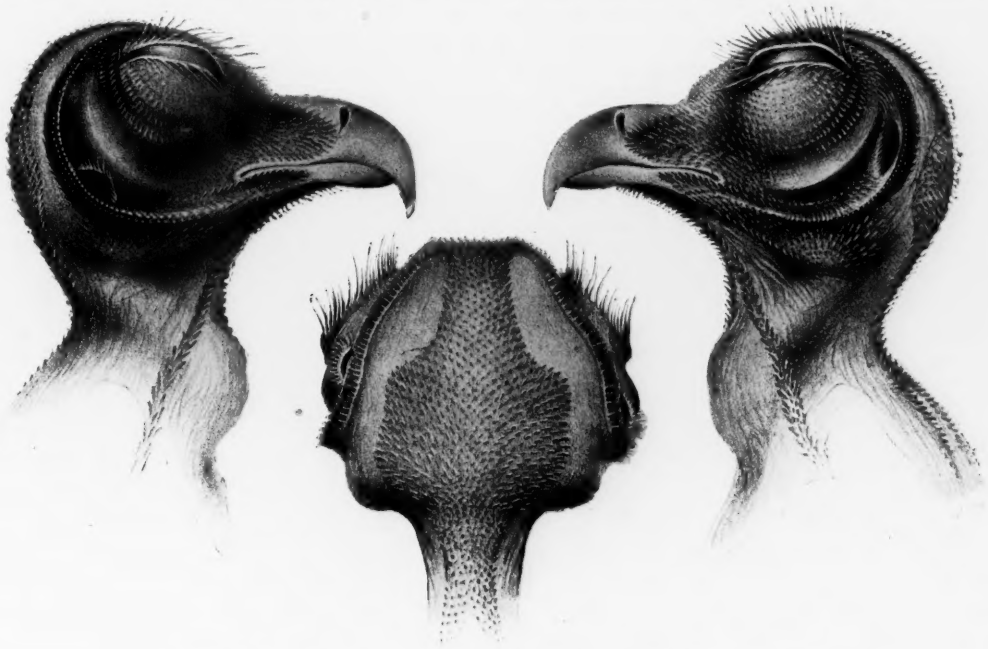

FIGURE 9. The Ear of *Photodilus* (after Pycraft, *Ibis*, 1903).

ASTRONOMICAL SPECTROSCOPY WITH SIMPLE INSTRUMENTS.

By W. ALFRED PARR.

SOME months ago* there appeared in these columns an article setting forth the truly surprising results obtainable with small telescopes, when applied with diligence and discretion to celestial phenomena—results at once so gratifying and promising in their nature as to render a modest, but really good, achromatic telescope of from two to three inches in aperture one of the choicest of possessions. Indeed, it has been well said that for pleasure-giving qualities as well as for actual durability, there are few "toys" to compare with such an instrument, except it be a violin! When we reflect that Schwabe's "imperturbable telescope," which secured for its owner the discovery of sun-spot periodicity, was merely a small instrument such as might be found in the equipment of any ordinary amateur; that Messier's cometary discoveries were all made with a telescope of only two-and-a-quarter inches aperture; and that Celoria's star-gauging researches were conducted with a four-inch refractor, we may well accord the smaller members of the telescope family an honourable place beside their giant relations.

But there is one department of observational astronomy left unnoticed in the article above referred to, and that a department in which the instrument of small aperture, far removed from being only a delightful and possibly useful "toy," may actually rival, if it does not in some cases even have an advantage over, the telescope of mammoth dimensions. I allude, of course, to spectroscopy. Although in the case of stellar spectroscopy a large telescope in general has the advantage, small instruments, if intelligently used, can also prove extremely effective, as was pointed out by Prof. George E. Hale in his lecture delivered before the Royal Astronomical Society on June 26th, 1907, while Prof. A. Fowler, in his interesting series of articles on the "Chemistry of the Stars," contributed to *Knowledge*† a few years ago, reminds his readers that Fraunhofer secured his epoch-making discoveries with a telescope only a little over an inch in aperture! As a matter of fact no more elaborate instrumental outfit than a three-inch altazimuth refractor, fitted with a simple Zöllner star-spectroscope, such as is frequently figured in the advertisement pages of this magazine, is amply sufficient for mastering some of the leading distinctions in the science which has been fitly termed by the Germans *Die Sprache des Himmels.* The spectroscope in question is a simple combination of three prisms and a cylindrical lens, so mounted as to fit over the astronomical eyepiece—preferably one of low power—like an ordinary sun-cap, and with this modest addition to his telescope the amateur will find his interest in the stars at once deepened and broadened, for, to quote the late Prof. Keeler, "the light which reveals to us the existence of the heavenly bodies also bears the secret of their constitution and physical condition." Instead of forming the usual point of light, the star's image will now be found to be transformed into a beautiful ribbon of coloured light, crossed at intervals by the distinctive dark lines which constitute the "signature" of the particular star under observation, and it is precisely in the wonderful variety in these signatures, forming, as they do, a veritable script to the "language of the heavens," that the great fascination in stellar spectroscopy resides. Secchi's classification of stellar types, in its broadest outlines, can be easily followed with the means just described, and I have made a drawing (Figure 1) of some of the more easily seen star-spectra as they actually appear, viewed in my three-inch Steward refractor, fitted with a Zöllner spectroscope. The stellar spectrum corresponding to Secchi's Type I, in which the hydrogen lines $H\beta$ and $H\gamma$ are so prominent, as in the case of Sirius and Vega, is perhaps the easiest of observation; but by far the most beautiful and interesting spectrum for a small instrument is that of Type III, as exemplified in Beteleux and α Herculis, in which the absorption bands exhibit the most delicately-pencilled flutings, all plainly fading, as is characteristic of this type, towards the red end of the spectrum. Stars of Types O and II, which include the helium and solar stars respectively, are rather difficult for the means at our disposal, but even they will yield legible spectra on a fine night. Certainly no more absorbing study can be imagined than such an enquiry, elementary though it be, into the main features of stellar chemistry, for the spectroscope, slipped over the eyepiece of the telescope, at once renders the stars eloquent in a manner impossible before. The message now is a definite one for each individual bright enough to impress our simple apparatus, thus giving up the secret of its evolution, and lending a significance to Letitia Barbauld's lines:—

> "But are they silent all? or is there not
> A tongue in every star that talks with man
> And woos him to be wise? nor woos in vain."

of which the gifted poetess herself, though a contemporary of Fraunhofer, could scarcely have had the barest inkling.

In stellar spectroscopic work, however, the source of light is, at best, a feeble one, and the users of large apertures therefore have a certain advantage, as stated before, but the case is very different when we turn to solar spectroscopy. Here there is a superabundance of light available, and it is precisely in

* See "KNOWLEDGE" for May, 1901, p. 184.

† See "KNOWLEDGE" for April, 1903, p. 80.

this department that the small telescope becomes a really efficient weapon of research. In the lecture already referred to, Prof. Hale goes so far as to say that "for a study of the general characteristics of the

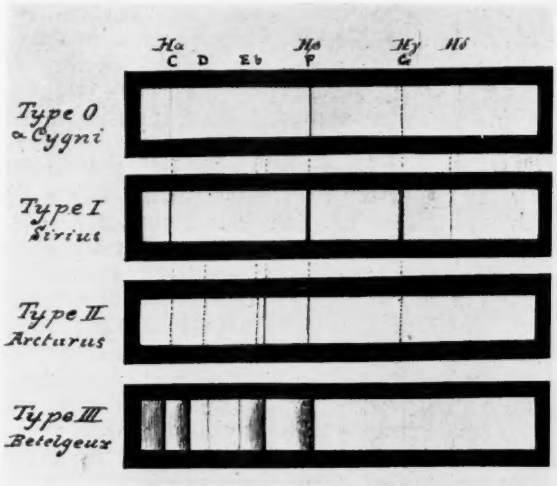

FIGURE 1.

Some of the more easily seen star spectra as viewed in a three-inch refractor fitted with a Zöllner spectroscope.

solar prominences the small instrument has even a great advantage over the large one." The amateur desponding over modest instrumental means will find these to be very encouraging words indeed, coming, as they do, from one who has had the use of the greatest refractor in the world; but Prof. Hale goes on to show that an instrument like the forty-inch Yerkes telescope is wholly unsuited for work of this kind, as the images of the prominences formed by it are usually far too large to be included within the slit of the spectroscope without admitting too

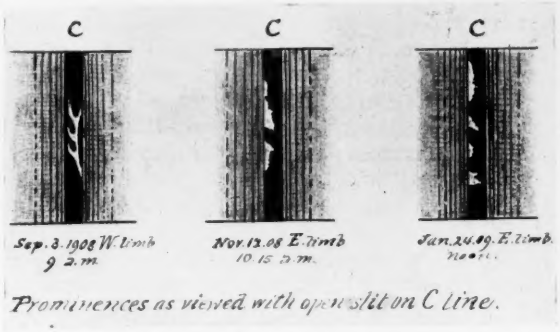

FIGURE 2.

Some groups of prominences seen with the apparatus shown in Figure 3.

much general light from the sky, and he suggests as "an almost ideal equipment" a telescope of about four-inches aperature, used in conjunction with a small, but suitable spectroscope. There now only remains the latter consideration, but, since the introduction a few years ago of replicas in celluloid of Rowland's celebrated diffraction gratings, prepared at a comparatively small cost by Thorp, Wallace and Ives, there is no difficulty in placing a solar spectroscope in the hands of the amateur, such as will enable him to undertake work of real value, and a glance at the pages of the *Journal of the British Astronomical Association* is sufficient to show that such has already been achieved by several of its members. Attaching, then, one of these transmission grating spectroscopes, provided with an adjustable slit, to a three-inch telescope, and arranging matters so that the image of the sun, formed by the object glass, is sharply focussed on to the tightly closed slit, the solar spectrum, crossed by hundreds upon hundreds of the exquisitely fine dark Fraunhofer lines, will be seen spread out in all its pageantry of gorgeous

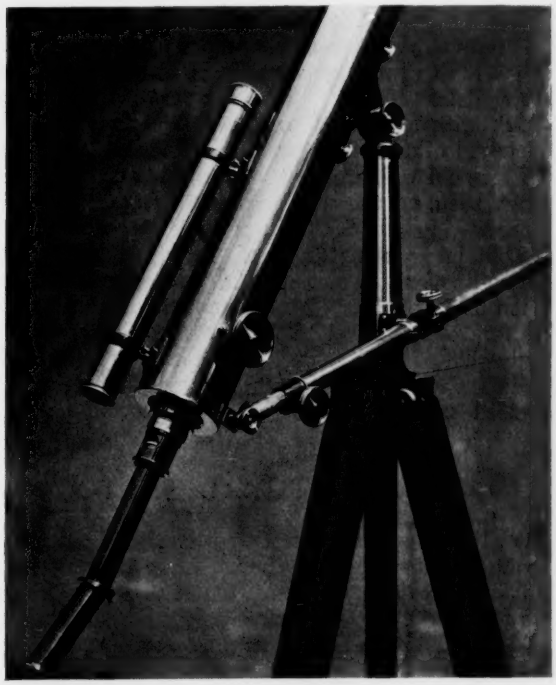

FIGURE 3.

Three-inch Altazimuth Refractor, with solar spectroscope attached.

colour. This in itself is an interesting and beautiful spectacle, but if now the telescope be so manipulated as to place the slit tangential to the solar limb, the strong dark line C, situated near the red end of the spectrum, will be seen brightly reversed for part of its length, as will also the fine line D_3 in the yellow portion, indicating respectively the glowing hydrogen and helium existing in the solar chromosphere. On slowly rotating the whole spectroscope, taking care to keep the slit constantly tangential to the sun's limb, certain brilliant notches may be observed on the C line in some positions of the instrument, betraying at those particular points, the presence of prominences, and if then the slit be carefully opened, the entire form

and feature of the prominence in question may be viewed in the scarlet light of hydrogen on the now broadened and diffused C line, for it should be borne in mind that the Fraunhofer lines, being, after all, but the dispersed images of the slit, become diffused and indistinct as soon as the latter is opened. In Figure 2 I have attempted to depict some groups of prominences as observed with my own equipment, viz., the three-inch refractor already noticed, and a transmission grating spectroscope by Hilger; though I should add that the small-view telescope, seen attached at an angle to the spectroscope, in Figure 3, has merely the function of bringing a somewhat enlarged image of the red end of the spectrum into the centre of the field of view, and is by no means an indispensable adjunct to the outfit.

It must be confessed that the manipulative dexterity which the employment of an altazimuth mounting renders necessary in order to retain the solar limb exactly on the slit, is certainly of a far more delicate nature than that required for stellar work with a Zöllner spectroscope, but it is easily acquired after a little practice. Indeed, the results so far achieved, even with this modest arrangement, have been, on the whole, as gratifying as they are encouraging, and the thrill of pleasure I experienced on obtaining my first view of the exquisitely delicate flame-like images of the solar prominences will not soon be forgotten. But the element of pleasure, as I have endeavoured to point out, need not be the only one involved, for we have here a department in which the amateur may offer very material aid indeed to his professional colleague, if he will, for instance, undertake the task I have elsewhere‡ suggested, of securing a successive survey of the entire ring of prominences visible on every sunny day; and, provided his observations be made about noon, and due attention be paid to the monthly ephemeris for the inclination of the Sun's axis, no serious difficulty need be experienced in locating within very moderate limits of error any individual prominence seen on the solar limb, even with so simple a spectroscopic outfit as the one I have described.

Now, since it is generally agreed that a proper attack on the problem of stellar evolution must begin with the study of the Sun—our nearest star,—it is surely something more than a fortunate coincidence that the amateur finds his greatest opportunities centred more particularly in this sphere of work, and Prof. Hale, in his profoundly interesting book, *The Study of Stellar Evolution*,§ while paying generous tribute to the work already done by the private observer, unfettered as he is by the traditions of institutions, and driven frequently by his own initiative into unexplored fields, devotes considerable space to the development of fresh suggestions by which such work may be carried on in the future with still greater confidence and success, so that the late Miss Agnes Clerke certainly did not overstate her case when she wrote "The new physical astronomy is, in a special manner, the science of amateurs, for it welcomes the most unpretending co-operation, and there is no one with a true eye and a faithful hand but can do good work in watching the heavens."

A NATURAL HISTORY MUSEUM FOR BIRMINGHAM.

AT a largely-attended meeting of Midland Naturalists, held by courtesy of the Lord Mayor in the Council Chamber, on Monday, June the 20th, it was decided to form a Natural History Museum in Birmingham. The Lord Mayor, in opening the meeting, said that if a Natural History collection was started the City Council would undertake to maintain it, and see that the specimens were kept in perfect order so that they would not fall into such an unsatisfactory state as the old collection at Aston Hall. He then called upon Sir Oliver Lodge, Principal of Birmingham University, to propose a resolution.

Sir Oliver Lodge moved "That this meeting heartily approves of the establishment of a Municipal Natural History Museum worthy of the City." He followed with a short speech, pointing out the various and many ways a collection could be formed, such as the gift of a private collection, which he remembered was the case in Liverpool, where a member of the Derby family gave a collection making the nucleus around which the present museum there had been formed. Sir Oliver went on to state the chief uses of such an institution in city life, where, owing to the rush and stress, people paid less and less attention to nature, and if it were not for museums such as it was proposed to found, where the way in which objects were shown attracted people, the marvels of nature would be quite unknown even to the educated. Some could study Birds, Botany, etc., in their holidays, but to how few was this possible. He also thought that a museum of such a kind would be of interest to manufacturers for the study of design at first hand.

Sir George Kenrick, seconding the motion, thought that they would be just as much justified in relying on public support for a Natural History Museum as the promoters of the Art Gallery had been.

A number of other speakers emphasised strongly the value of a museum such as it was proposed to form, pointing out that it would be an advantage to Birmingham as a whole, and especially to naturalists. The motion was carried unanimously, and a strong committee appointed to carry it into effect.

‡ *Journal of the British Astronomical Association*, Vol. XIX., p. 395.

§ London: Wm. Wesley & Son, 1908. See especially Chapter XXV. on "Opportunities for Amateur Observers."

NOTES.

ASTRONOMY.

By G. F. CHAMBERS, J.P., F.R.A.S.

HALLEY'S COMET.—The following account of Halley's Comet, as seen by an amateur, Mr. R. Wilberforce, (son of the late Bishop of Chichester), at Accra, on the West Coast of Africa, is extracted from a letter dated May 18 :—

"I cannot make out that you are seeing Halley's Comet at all well in England, as, according to my 'Daily Paper,' it has been rather a feat, so far, for anyone to have seen it with the naked eye. Here everyone has gone mad over it. We nearly all get up at 4 a.m., and sit and gaze at it till it gets light. It is *the* most wonderful thing ever seen. The Comet itself never rises far above the horizon, but its tail, which stands straight up, is like the rays of a very powerful searchlight—so long that it reaches from the horizon to the very roof of the heavens; and so broad that it occupies roughly one-fifth of the arc of the sky; and its light is so powerful, that combined with Venus (which is also lovely just now), it has almost the effect of a midnight sun. The natives are frightened to death of it, and will have it that it means an earthquake coming."

THE GREAT COMET OF 1861.—A letter dated June 3rd, 1910, has been received by Mr. G. F. Chambers from Mr. Henry W. Dunn, of 3019, Van Ness Avenue, San Francisco, California, U.S.A., which seems to throw some new light on the great comet of 1861. Mr. Dunn's account of it is written with evident good faith, but it is not easy to reconcile his statements with the traditional history of the comet as recorded in England. Mr. Chambers was himself an eye-witness of the comet, and perfectly well remembers his first view of it on the evening of Sunday, June 30th. Mr. Dunn's statement, quoted from a Prof. Davidson, that the theory of the earth having passed through the comet's tail was not propounded until a much later date, and was wholly of an *ex post facto* character is undoubtedly erroneous, for Mr. E. J. Lowe's remarks on the subject were published in *The Times* only a few days after the comet's appearance.

The following is the text of Mr. Dunn's letter :—

"SIR,—The visit of the Halley Comet this year created a great interest and excitement in California, as in the world elsewhere. It brought to public notice preceding comets of note, and amongst others, the remarkable comet of 1861, through the tail of which astronomers *claim* that the Earth passed. I was living in this city when the 1861 comet was seen, and as my memory of its date of appearance and peculiarities differs from the published account in your work 'The Story of the Comets,' I have taken the liberty to address you. The circumstances of my knowledge are as follows :—

"My wife was confined on the 24th June, 1861. On the morning of that, or the preceding day, at 4 a.m., a large comet was seen by some printers going home from night work. On the same evening, about 9 p.m., I had occasion to go into my yard, which faces nearly north. I noticed that objects seemed unusually distinct, there being no moon at the time. Looking upward I was astonished to see numerous broad trails of light spanning the heavens from west to east from behind an adjacent house in the west, until the trails vanished behind an adjoining height in the east. The distance or length of the trails was about 100 degrees. The position was nearly parallel, but about 15 degrees from the zenith, and width where the trails vanished behind the adjacent house about two degrees or four moons' diameter, whilst the broader part, going over the hill, was three or four times as great. The Polar or North Star was quite out of the line of the tail, being north.

"The trails, or sectors of the trail, I did not count, but there must have been five if not six, each of which was composed of strias or lines—I think four in number—these being like bricks of light gold colour, with interstices of the sky between. I did not know of the importance of a precise description to the astronomical world, or I would have gone upon the hill and seen the nucleus if it had been in sight, and the eastern end of the sectors if they did not vanish below the horizon. The next night I looked to see the comet, but according to my memory—which is exceptionally good—saw nothing of it in the sky. A comet is reported to have been seen on the night of the 30th June and later on, and recognised as the one seen by Mr. Tebbutt, in New South Wales, as early, I think, as May 16th, 1861. This comet is noticed in the newspaper *Alta California* published in this city, dated July 2nd; I herewith enclose a copy of the account. The description is imperfect, as might be expected from the pen of a reporter. In looking over your work, i.e., 'The Story of the Comets,' I saw the drawing and description of the "De Cheseaux" Comet of 1744 and I have to state that the comet that I saw in 1861, and have described, was approximately the same in appearance, with the exception that the sectors were closer together, and that there were *lines* of brick-shape gold light, instead of outside lines of light with fainter interiors.

"My impressions are that the comet of June 23rd or 24th, 1861, was an entirely different one from that said to have been seen here on the 30th June, and described in the *Alta California*. The one I saw was a wandering comet—if I may so describe it—that suddenly came into sight and passed and disappeared in the sunlight in about 24 hours, and was seen no more. I do not think any astronomers on the Pacific coast of North America made note of the comet I saw. Prof. George Davidson, the most distinguished of our astronomers, was in Pennsylvania at the time and did not see it. There were no observatories on the Pacific at that time, and in the Atlantic, or Eastern States, the excitement and turmoil of the commencement of the Great Civil War caused it to be overlooked.

"I do not think the Earth passed through the tail of the comet, and Prof. Davidson informed me that it was many years later that astronomers, by analogy, guessed and decided that the incident occurred. Prof. Brooks, at Geneva, New York State, within the past two years saw a comet in the early morning which was seen by others on that date but not again."

"MAGNIFICENT COMET."—From the *Alta California* newspaper of July 2nd, 1861 :—"The city was surprised last night by the sight of a magnificent comet. Nothing had been heard of it, and all at once it appeared high above the horizon, a comet of the first magnitude, blazing with a glory seldom equalled. It must be moving with extraordinary rapidity, even for a comet; usually such bodies when first seen are faintly visible in the distance, or on the edge of the horizon, and not until after they have long been in sight or for many days do they attain their full splendour. So far as we can learn this comet was first seen in California on Saturday evening, and at the time of our latest news from the Atlantic States it had not been observed, or even foreseen, by astronomers.

The position of the comet at nine o'clock last evening, was about thirty degrees above the horizon. It is fifteen degrees from the North Pole, and about twelve degrees from the large star in the head of the constellation of the Great Bear, and is just on a line with that star and the last star in the tail of the Bear. The tail of the comet, which is about sixty degrees long and three degrees wide at its widest part, shoots up between the Bear and the Polar Star.

"The nucleus is larger than a star of the first magnitude, several times larger than Venus, but its light is paler than that of the planet."

VISITATION OF THE ROYAL OBSERVATORY.—A fortnight late, owing to the ill-health of the Astromer Royal, Sir W. H. M. Christie, the annual visitation took place on the afternoon of Saturday, June 18th. Besides the official Board of Visitors, as usual, many others interested in Astronomy received invitations, and many familiar faces were to be seen inspecting the various instruments, whilst the various members of the staff endeavoured to enlighten the visitors who found difficulties in grasping the meaning of what they saw. The day was hot, and nearly clear, so the 28-inch was trained upon the double star γ Leonis, and the great Thompson telescope on Regulus, but what with a heated atmosphere, and tremor from other sources, the stars though readily seen were very poorly defined.

XUM

The routine work of the Observatory has been maintained. No less than nine thousand four hundred and thirty-one transits having been observed with the transit circle, whilst eight hundred and twent-eight additional observations were made for the determination of errors. It must be remembered that for exact work, the astronomer does not accept that his instrument is perfect, but, on the other hand, is constantly trying to find out its defects. With the Alt-azimuth three thousand eight hundred and sixty observations were made, and eight hundred and nine additional adjustment observations. Micrometrical observations of six hundred and forty-five stars were taken with the twenty-eight inch, two-thirds of which were less than two seconds apart.

With the 26-inch, one hundred and forty-eight photographs were secured, and with the 30-inch reflector on the same stand one hundred and seventy-four more photographs were taken. The first photo of Jupiter's eighth satellite this year, on January 19th, showed it to be within seven seconds of the place expected according to the calculations of Messrs. Cowell, Crommelin, and Davidson. Since its discovery it has made a complete revolution of its orbit.

The 13-inch Astrographic equatorial has also been busy, one hundred and twenty-nine good photos having been made. Halley's Comet has been photographed forty-four times with the 30-inch and twenty-eight times with the 13-inch.

Daily photographs of the sun were taken on one hundred and ninety-four days, and the omissions filled in, with the exception of August 1st and November 5th, 1909, by photo-heliograms from the two Indian Observatories of Kodaikánal and Dehra Dûn. With the beginning of March daily photographs of the Sun were commenced at the Cape of Good Hope. This is an important advance.

The principal results of the Magnetic Observations for 1909 are:—

Mean Declination +	...	15°·47′·6 West.
Mean Horizontal Force	...	4·0179 British Units. 1·8526 Metric Units.
Mean Dip (with 3-in. needles)		66° 53′ 57″.

The mean temperature of the year 1909 was 48°·6 or 1°·0 below the average, but the winter yielded six fewer nights than usual when the temperature reached freezing point. May, 1909, was exceptionally sunshiny, whilst June was the dullest and coldest on record. A few years since the meteorologists were puzzled by the annual shortage of rain, about a year's rain less than the reckoned average having fallen in a period covering nine years. Since that time the fall has increased, so that in the year ending April 30th, 1910, there has been 3·6 inches in excess of the average. "The greatest daily amount was on April 16th, when the total exceeded an inch and a half, most of which fell between 5^h and 9^h p.m., and more than half between 5^h and 6^h p.m. For the first time on record February provided a rain spell of fourteen rainy days from 10th to 26th inclusive.

Beside these observations and their reduction a considerable amount of work is found in distributing time signals and rating chronometers for the Admiralty.

At the present time there is a vacancy in the staff, one of the Chief Assistants, Mr. Cowell, having just left on his appointment to succeeed Dr. Downing as Superintendent of the Nautical Almanac. F. C. DENNETT.

BOTANY.

BY PROFESSOR F. CAVERS, D.Sc., F.L.S.

SEXUALITY OF THE RUST FUNGI.—Six years ago Prof. Blackman (*Ann. Bot.*) described his discovery that in the young "cluster-cup," or aecidium, of certain Rust Fungi (Uredineae) a curious process of fertilisation occurs, the nucleus of an ordinary or vegetative cell of the fungus passing through the cell-wall into a differentiated female cell, which bears on its tip a smaller cell regarded as representing, in an aborted state, the trichogyne or receptive process of the oogonium in Red Algae and Ascomycetes. In the following year Christman (*Bot. Gaz.*, vol. 39, 1905) published an account of similar observations, in which, however, conjugation occurred between two equally differentiated cells lying side by side. That is, according to Blackman the process of conjugation is heterogamous, while Christman describes it as isogamous. Olive (*Ann. Bot.*, 1908) stated that in one and the same plant there may be formed in the wall between the two cells either a narrow opening through which the male nucleus passes into the female cell, or a wide pore allowing the protoplasmic contents of the two cells to mingle. Kurssanov (*Zeit. Bot.*, 1910) has re-investigated the subject, and finds that the two conjugating cells not only lie side by side and are of about equal size, but that both have a sterile cell, which he regards as acting merely as a buffer between the fertile cells and the epidermis of the leaf in which the fungus is growing as a parasite. He therefore doubts any connection or direct relationship between the Rusts and the Red Algae, though he admits that the differences in the methods of conjugation observed by Blackman, Christman, and Olive may be due simply to differences in the forms investigated, or to a pathological nuclear migration which he has often observed accompanying the normal sexual process.

COLOURED LIGHT AND PHOTOSYNTHESIS.—Much has been written on the question of the part played by the various rays of the spectrum in the process of photosynthesis. The matter cannot yet be said to have been finally settled, but the methods used and the results obtained recently by Kniep and Minder (*Zeit. Bot.*, 1909) are of great importance and promise, as indicating the lines of work which seem likely to lead to a solution of the problem. In the light used in their experiments all heat, as well as the infra-red and ultra-violet rays, was cut off by distilled water containing traces of potassium dichromate and copper sulphate. The screens were of specially coloured glass, spectroscopically tested, and the rate of photosynthesis was measured by counting the bubbles of oxygen evolved from water-plants. Green gave no photosynthesis, while blue and red light of equal energy intensity gave equal rates of synthesis. This result runs counter to the generally accepted view that the blue rays of light play but little part in this all-important process in plant-life. This view is largely accounted for by the fact that the blue screens that have hitherto been used in experiments reduce the energy intensity of the light they transmit to a much greater extent than do the red screens, and from the work of Kniep and Minder it is evident that the relative value of the two portions of the solar spectrum is approximately proportional to the energy amounts of the two portions. These investigators, whose work has already yielded so much of interest, intend to pursue the question further, and, by the use of suitable screens and of more precise methods than have previously been adopted, hope to study in detail the photosynthetic value of each portion of the spectrum on the basis of its energy value.

MOVEMENT OF FOOD MATERIALS IN PLANTS.—The movements of food materials in plant organs obey the ordinary laws of diffusion, any given substance moving in the direction of its lowest concentration. Rywosch (*Zeit. Bot.*, 1909) has studied the *means* by which the "gradient" in these movements is maintained, and his results are of great interest from this point of view, which does not appear to have been previously investigated. If the cuticle is removed from one side of a pine leaf, or "needle," which has been kept in darkness until it no longer contains starch, and the leaf is placed in a sugar solution, the first deposit of starch is found, not on the side of the removed cuticle, where, of course, the sugar is most concentrated, but on the distal side. As the sugar enters on one side the sugar on the opposite side is more completely condensed, thus maintaining a "falling gradient," and a continual diffusion stream towards the distal side. In the cotyledons of the pea, Rywosch finds that the sugar is more completely condensed as the vascular bundles are approached, thus maintaining a falling gradient and diffusion of sugar towards the bundles.

LIGHT AND GERMINATION.—It is now known that the seeds of a considerable number of plants will not germinate in darkness, and that in many other cases light favours germination though it may not be essential. Kinzel (*Ber. deutsch. Bot. Ges.*, 1909) lists over sixty species that

germinate only in the light, though he does not state whether high temperatures can replace the necessity for light, as is known to be the case with fern spores. On the other hand the seeds, of *Phacelia* and *Nemophila* germinate very slowly and sparingly in white light, more rapidly and abundantly in darkness, and most quickly and completely in blue light. In the case of *Nigella sativa*, Kinzel had previously shown that seeds placed at once in darkness at 20° C. germinated well, while seeds kept at any temperature in the light remained for many weeks without showing signs of germination, and on being transferred to darkness still failed to germinate at 20°, but germinated abundantly on the temperature being raised to 30°. As a contrast to these "lichtharte" seeds, the seeds of some other plants were found to behave in an exactly opposite manner; they germinated readily if at once placed in the light, but after being exposed to germinable conditions in darkness for about three weeks failed to germinate when transferred to light. In the case of one of these "dunkelharte" seeds, belonging to *Ranunculus sceleratus*, Lehman (*Ber. deutsch Bot. Ges.*, 1909) found that one per cent. Knop's culture solution gave a greater percentage of germination in darkness than did distilled water in light, and that the use of soil instead of wet filter—paper (generally employed in such experiments) greatly stimulated germination—water extracts of soil made with boiling water were less effective, while extracts made with cold water showed no stimulation at all.

THE CRETACEOUS FLORA OF JAPAN.—In a recent paper, read before the Royal Society, Dr. Marie C. Stopes and Prof. Fujii describe numerous remains of Japanese fossil plants of Cretaceous age. The plant-remains were found in nodules similar to those occurring in the Carboniferous strata of Britain, and owing to their mode of preservation, by a process of petrifaction or replacement of the tissues by mineral matter, the minute structure of a great variety of plants has been made out. The plants discovered include parasitic Fungi; Fern stems, leaf-stalks, sporangia, and roots; stems, leaves, roots, and cones of Gymnosperms; Angiospermic stems; and the flower of what appears to be a Monocotyledon. A remarkable feature of this Cretaceous flora, as compared with those usually represented by leaf-impressions only, is that the proportion between the numbers of Angiosperms and Gymnosperms is fairly evenly balanced.

THE MECHANISM OF VENUS' FLY-TRAP.—The well-known Venus' Fly-trap (*Dionaea*) captures insects in a curious manner: the leaf resembles an opened book, and when an insect touches any of the six long sensitive hairs—three on either "page"—the two halves suddenly close up and hold the insect fast. The closure of the *Dionaea* leaf has recently been investigated again by Brown and Sharp (*Bot. Gaz.*, vol. 49), who have extended the observations of Darwin and others on this plant. They find that the closing response depends upon the intensity rather than upon the number of stimuli applied, the number of stimuli required varying in the inverse order of their intensity. The response is normally brought about by the compression of certain cells at the bases of the sensitive hairs, but the compression of other cells of the leaf-blade also causes closure, and it is probable that the latter cells are quite as sensitive as those at the bases of the hairs—this conclusion is based on the results of experiments in which mechanical, electrical, and thermal stimulation was used. The closing response follows a combination of stimuli of two kinds when consecutively applied, *e.g.*, heat and an electric shock, heat and pressure, and so on, when the individual stimuli are of such intensity that either alone would be insufficient. Cold water allowed to fall on the leaf causes closure only when it bends a sensitive hair.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (Oxon)., F.I.C.

THE RETTING OF FLAX.—During the last year or two numerous patents have been taken out with the object of obtaining a fibre of better colour and lustre from flax. The process of separating the bast fibres from the ligneous tissue of the stalk is known as *retting* (rotting), and is based upon a slow decomposition of the material into its constituents. For this purpose the flax stalks, after removal of the seeds, are steeped in running water *(water-retting)*; or are exposed to the action of rain and air *(dew-retting)*; or are treated by both methods *(mixed retting)*. The change that takes place is mainly a bacterial decomposition brought about by a specific micro-organism *Granulobacter pectinovorum*, which is usually accompanied by a less active micro-organism, *Granulobacter urocephalum*. A certain degree of retting may also be produced by the hay bacillus and some other aërobic bacteria, but acetic and lactic acid bacilli are inactive in this respect.

The chemical reactions that occur have been investigated by Beijerinck and Van Delden, (*Woch. für Brau.*, XXI, 85), who have found that retting is essentially a process of fermentation of the pectose in the cells about the bast fibres, first into pectin and then into sugars, brought about by a specific enzyme, *pectinase*, secreted by the bacteria, and promoted by the frequent changes of water which the flax usually receives in the early stages of the decomposition. Certain kinds of water and climatic conditions appear to be peculiarly favourable to this fermentation, and the excellence of the fine cream-coloured flax of Courtrai, which is reputed to be the best in the world, is commonly attributed to the nature of the fermentation set up in the sluggish waters of the River Lys. Other varieties of Belgian flax lack this fine colour, and that from Brabant is so dark as to be known commercially as "blue flax."

One great drawback of river retting is the pollution of the water with decomposing vegetable matter, and various processes have been devised to remedy this, while at the same time accelerating the fermentation. One of the best known of these is that patented by Loppens and de Swarte, in which the flax straw is placed vertically in a tank, through which passes an upward current of water. The substances dissolved by the water form a heavy solution, which falls to the bottom of the tank, and is replaced by fresh supplies of water from below. It is probable that the general adoption of a process of this kind, coupled with the use of cultures of suitable bacteria, would enable flax grown in any part of the world to equal that retted in the Lys.

PRODUCTION OF A LIGHT METAL.—A recently published French patent (No. 407,814) claims a process of manufacturing alloys of magnesium and zinc containing from 90 to 96 per cent. of the former and from 10 to 4 per cent. of the latter metal. The zinc may be replaced wholly, or in part, by copper, or an alloy of copper and aluminium, while calcium or beryllium may take the place of the magnesium. The method of preparing these alloys is to melt the magnesium in a closed iron crucible, and to add subsequently the zinc or other metal. The advantages claimed for the alloys are that they are not affected to any appreciable extent by exposure to atmospheric influences, that they can be readily cast or forged, and that they can be turned, like brass.

ACTION OF SEWER GAS ON PORTLAND CEMENT.—Mr. S. H. Chambers describes, in the *Chem. Trade J.* (1910, 46, 433), the results of his investigation of the action of sewer gas upon Portland cement. The experiments were made on a large scale at the Hampton Sewage Works, the whole of the installation being constructed entirely of concrete. It was found that after being in use for a few months the roof and walls above the liquid became coated with a yellowish deposit of sulphur, and later on gave indications of peeling. The surface of the disintegrating concrete was then found to contain 66 per cent. of calcium sulphate. Below the level of the liquid the cement was unaffected. The corrosive action of the sewer gas was attributed to the oxidation of the sulphuretted hydrogen into sulphurous and sulphuric acids. The conditions required for good Portland cement to be injuriously affected in this way are:—(1) A high degree of putrescence; (2) A moistened surface to absorb the gaseous products; and (3) A free supply of air to effect the oxidation.

XUM

INFLUENCE OF SALTS ON HIGHER PLANTS.—The current issue of the *Bull. Soc. Chim. Belg.* (1910, 24, 200) contains an account of the experiments made by M. A. Grégoire to determine the influence of readily hydrolysable salts (*i.e.*, containing weak acids or bases) upon rye plants, which were grown in solutions containing, in addition to the usual nutrient substances, compounds such as calcium carbonate and silico-humate. The effect of the calcium carbonate was slightly injurious, while the silico-humate was manifestly harmful. On the other hand, other easily hydrolysable salts had a stimulating effect upon the growth of the plants, and it would seem, therefore, that salts of this nature may have a special influence upon a plant, apart from their nutritive value.

ECONOMIC BIOLOGY.

By WALTER E. COLLINGE, M.Sc., F.L.S., F.E.S.

THE ASSOCIATION OF ECONOMIC BIOLOGISTS.—The ninth (Annual) General Meeting, which is to be held at the University of Manchester on July 6th, 7th and 8th, under the presidency of Professor George H. Carpenter, B.Sc., promises to be a most successful gathering. Amongst those who will contribute papers we may mention Professor Sidney J. Hickson, F.R.S., Professor F. E. Weiss, Professor Percy Groom, Dr. Walter Malden, and Dr. R. Stewart MacDougall.

"Biology—Pure and Applied" is the title of the President's address, and amongst other subjects down for discussion are "The place of Economic Zoology in a modern University"; "Plant hybrids"; "Diseases of bees"; "The problem of wild-bird protection"; and other more technical subjects. The formal opening of the University Biological Experimental Laboratories will take place on the afternoon of July 7th, to be followed by a garden party, to which the Council of the University invite all members of the Association.

THE RELATION OF BIRDS TO THE FRUIT-GROWER.—The relationship of wild birds to agriculture generally is one that is annually coming to the front, and there is a keener demand than ever for accurate information upon this matter. In the United States of America a careful study of Californian birds in relation to fruit cultivation has been in progress for some years, with a view to ascertaining the exact nature of the food of those birds frequenting orchards, and to publish such information as will enable the orchardist to discriminate between his friends and foes. The first part of such a report has now been completed, and will be issued at no distant date.

INSECT PARASITES OF INSECTS.—Whatever may be the practical value of insect parasitism, and opinions are very varied, the scientific study of the subject has brought to light a large number of new genera and species of small hymenopterous insects of more than usual interest. Following up a recent publication by Dr. L. O. Howard, Mr. J. C. Crawford continues the description of more of these Chalcidoid parasites from the Gypsy Moth (U. S. Dept. Agric., Bur. of Entom., Tech. Bull. No. 19, pt. ii.). As in the previous publication, all the specimens come from Japan, eight of which belong to new species.

THE ECONOMIC VALUE OF COLLEMBOLA.—In two recent papers (*Journ. Econ. Biol.*, 1909, p. 83, and Journ. Econ. Entom., 1910, p. 204) I have set forth the harm that various species of Collembola, or Springtails, occasion to various plants as carriers of fungus spores, but that they should be found to be of considerable economic value may surprise many.

A small species (*Achorutes viaticus*) occurs in millions on a certain sewage farm. On the effluent that is left in the filter is a colloidal deposit, and from time to time the filtration has to be stopped in order to get rid of this deposit; but it has been found that wherever the collembola exist in any large numbers they destroy this colloidal deposit, and that there is, therefore, no necessity for stopping the process of filtration.

Whilst these tiny insects have been known to naturalists for hundreds of years it is only quite recently that they have been shown to be injurious to plant life, but it is still more interesting to find that some species at least have a beneficial side.

FUNGUS GNATS.—Of the various families of Diptera few have received so little attention in recent years as the *Mycetophilidae* or Fungus Gnats, and yet they are an exceedingly interesting family, both from the standpoint of the economic entomologist and the dipterologist.

There has recently appeared the first part of a most interesting and useful publication on the fungus gnats of North America (*Maine Agr. Exp. Stat., Orono, Bull.* 172) by Dr. Oskar A. Johannsen, in which the lower and economically less important sub-families are treated of and beautifully illustrated. In a subsequent part the author hopes to deal with the *Sciophilinae*, *Mycetophilinae*, and the *Sciarinae*, thus bringing to a conclusion a most useful and important piece of work.

GEOLOGY.

By G. W. TYRRELL, A.R.C.S., F.G.S.

CONTACT-METAMORPHISM IN THE SKIDDAW SLATES.—The well-known area of contact-metamorphism round the Skiddaw Granite, which, curiously enough, has never before been made the subject of a detailed investigation, is described in great detail by Mr. R. H. Rastall in the May volume of the Quarterly Journal of the Geological Society. He recognizes three well-marked rock-types involved in the metamorphism—black slate, grey flags, and grey grits. The black slate has undergone only a moderate degree of metamorphism, resulting in the production of chiastolite. Cordierite-bearing rocks from Sinen Gill and the central parts of the aureole are derived from the grey flags. Most of the granite contacts, however, are with grey grits. In these, thermal metamorphism is much less marked than in the other types, and has given rise to rocks resembling impure quartzites. It is shewn that the sedimentaries had already undergone extensive dynamic metamorphism, resulting in the production of cleavage, foliation and folding, prior to the intrusion of the granite. The new minerals produced by the heating are cordierite, andalusite, biotite and muscovite; kyanite and sillimanite are absent. This fact is significant, since the absence of these minerals is proof that the rocks were never subjected to a very high temperature.

The metamorphic aureole is of great size compared with the area of the visible exposures of granite. The latter, however, are only the protruding parts of the upper surface of a large laccolitic mass which underlies the metamorphosed area at a small depth. All the evidence goes to show that the granite consolidated under a thick cover, and was not very hot at the time of intrusion. These conditions favoured the maintenance of a moderate temperature in the surrounding rocks for a long interval of time, producing a very complete re-crystallization a long distance from the actual contact.

The igneous rock itself is described as an alkali-granite, containing alkali-felspar and a plagioclase poor in lime, in approximately equal proportions. Graphic structures occur between the quartz and a perthitic orthoclase—an example of a ternary eutectic. Both white and dark micas are present, together with a small amount of magnetite. Some of the felspars are markedly porphyritic, and it is suggested that these are not of early formation, but represent the excess of the felspathic component over the quartz-felspar eutectic ratio.

THE COMPOSITION OF FIRECLAY.—Prof. J. W. Gregory describes a fireclay from Glenboig, Lanarkshire, in a recent issue of *The Proceedings of the Royal Society of Edinburgh*. The seam occurs near the base of the Millstone Grit, and is of great economic interest, as the firebricks made from it are reputed to be unequalled in quality. Stigmaria roots are never found in the clay, which fact suggests that it had a different mode of origin from the typical English carboniferous fireclays. The constituents of the clay are quartz, fresh plagioclase, rare flakes of hornblende and mica, occasional crystals of zircon, and abundant needles or granules of rutile.

XUM

The clay-substance is an amorphous, hydrous bisilicate of alumina, shewn by chemical and mineralogical examination to be halloysite, not kaolinite. The most interesting constituent, however, is a hexagonal carbonate with good zonal structure and striking organic appearance, resembling some calcareous algae. They have the form of rhombohedra with curved faces. The specific gravity and chemical composition show that these crystals belong to sideroplesite, a member of the hexagonal carbonates, intermediate between siderite and dolomite. The characters of the sideroplesite show that it grew *in situ* at the time of deposition of the clay, and not by subsequent segregation. Prof. Gregory concludes that the fireclay was a lagoon deposit. The existence of the sideroplesite and the vertical position of some of the constituent flakes indicate that the rock was deposited in still water. The absence of fossils in a bed particularly well adapted for their preservation precludes the idea that the formation was of marine origin.

THE FLOW OF MARBLE.—In *The American Journal of Science*, for June, Prof. F. D. Adams and E. G. Coker give the results of an experimental investigation of the deformation of marble under enormous pressures. A cylinder of rock about 2-cms. in diameter and 4-cms. high was fitted accurately into a heavy tube of steel. Pistons of hardened chromium-tungsten steel were then inserted into the ends of the tube, and the pressure transmitted through them to the column of marble. In order that the condition of *differential pressure* might be satisfactorily developed, the enclosing steel tube was made thinner in the part surrounding the central portion of the marble cylinder. When the pressure was applied this portion of the tube bulged, allowing the marble to flow laterally. By enclosing the tube in a small stove of special construction. the pressure could be applied at temperatures up to 1000° C, The pressures employed ordinarily ranged from 120,000 to 130,000-lbs. to the square inch. In some cases the deformation was allowed to take place rapidly, and in other cases very slowly, the times occupied ranging from ten minutes to sixty-four days. Some striking photographs are given, shewing the bulge of the tube, and the compression of the marble. A column of marble 17-mm. in diameter, and 35-mm. long, under a pressure of 296,725-lbs. to the square inch, was reduced to a barrel-shaped mass 28·81-mms. in diameter, and only 17·3-mms. long. The deformed marble has developed in it a perfect foliated structure, each crystal of calcite having been flattened out so that in thin section it appears as a ribbon drawn to a point at either end, and eight to ten times as long as it is wide. There is no trace of granulation, and the movement set up in the rock is an example of perfect plastic flow. One of the most curious results of this investigation is that, under the conditions of the experiments, the presence of water had no recognisable influence on the character of the deformation. Also, the specific gravity of the rock was not increased by the pressure to which it had been subjected.

METEOROLOGY.

By JOHN A. CURTIS, F.R.MET.SOC.

THE WEATHER OF JUNE.—The month opened with rainy, unsettled and rather cool weather, with thunderstorms in places. Up to Saturday the 4th the highest temperature reported in the United Kingdom was 75° at Greenwich, but at many stations the maximum was much lower; at Harrogate only 63°, and at Douglas 57°, while in District Ireland N. the highest reported for the week was only 62°, —at Armagh, on the 1st. The lowest readings were below 40° in many places. The week ended June 11th, however, was unusually warm, the maxima reaching 80° on the 9th, at Fulbeck, Lincoln, and at Greenwich, and the District mean over the greater part of England being from 4° to 5° above the average. At individual stations the excess was as high as 7°. It was still rainy, however, and both rainfall and rainy days were, on the whole, in excess, while sunshine was in defect. Many thunderstorms were reported, some of them accompanied by heavy hail. The night temperatures were still low, and at Balmoral, readings of 33° in the screen and 31° on the grass were reported. Rather unsettled weather prevailed at the beginning of the next week, with thunderstorms and slight rain, but subsequently it became very fine and dry, though with a good deal of fog on the South and West coasts of England. The highest temperature was 78° on the 12th, at Bawtry, while at Nottingham and other places 77° was registered. The lowest observed was 32° at Balmoral, and 34° at Llangammarch Wells. The rainfall and rainy days were below average in all Districts, while sunshine was in excess, At Newquay in Cornwall the excess of sunshine for the week was 32·5 hours, or nearly five hours per day. The week ended June 25th was unusually warm all over the United Kingdom, with maxima up to 83° in England, E. and in the Midlands. Rainfall as a rule was in excess, though not to any marked extent, while sunshine was above the average in England generally, but below the average in Scotland and Ireland.

At Greenwich Observatory the highest temperature recorded in the period June 1st—28th was 82° on the 20th, and the lowest was 44° on the 16th. The rainfall amounted to 1·90 inches on 11 days, while the sunniest day was the 20th with 15·1 hours. The only sunless days were the 5th and 10th.

Radiation was very marked on the 16th June, when in the sun's rays, the black-bulb thermometer rose to 140°, while the minimum on the grass fell to 33°.

HALLEY'S COMET.—Balloons carrying self-registering meteorological instruments were sent up at stated times on May 18, 19, 20, from various stations. The appointed hours were:—

May	18	...	...	7 a.m.
,,	18	...	...	9 p.m.
,,	19	...	...	2 a.m.
,,	19	...	...	7 a.m.
,,	19	...	...	7 p.m.
,,	20	...	...	7 a.m.

Six of those sent up from Pyrton Hill in Oxfordshire have been found, and the records have been tabulated and published. These records show that the temperature gradient, or the rate of fall of temperature with increase of height, varied from 0·59° Centigrade to 0·68° Centigrade per 100 metres. The greatest gradient, 0·68°, was shown at 2 a.m. on the 19th, while the least, 0·59°, was recorded at 7 a.m. on the 20th. One of the balloons was picked up in the sea near Fleetwood, about 190 miles from the point of ascent. The greatest height attained was 17·6 kilometres, or 58,000 feet.

Seven of the balloons sent up by the Meteorological Service of the Uccle (Brussels) Royal Observatory (J. Vincent, Director) were recovered, and their records have been discussed. From the results it appears that over Belgium the atmospheric layers up to six thousand metres were, on the whole, somewhat warmer at 2 a.m. on the 19th than either at the preceding (18th, 9 p.m.) or succeeding (19th, 7 a.m.) ascents, while on the contrary, at the height of twelve thousand metres and upwards, the temperature was a little cooler. The isothermal layer was reached on each occasion at from eleven thousand to twelve thousand metres above the ground. One of the balloons sent up on the 18th reached the height of twenty-seven thousand, five hundred and ninety-six metres, or about ninety thousand feet. This height has, it is believed, only been exceeded on one occasion, namely on November 5th, 1909, when a height of nearly ninety-five thousand feet was reached by a balloon, also sent up from Uccle.

A magnetic perturbation was observed in Krakau by Professor M. P. Rudzki, in the early hours of May 19th. He gives the following measures of the declination, expressed in German mean astronomical time (one hour fast on Greenwich):

May 18.	Decl W.	May 18.	Decl. W.
$12^h\ 0^m$	$5°\ 22'\ 10''$	$16^h\ 15^m$	$5°\ 24'\ 30''$
13 0	23 10	16 45	23 10
14 0	26 10	17 30	25 10
15 0	17 40	17 45	25 20
15 15	17 40	20 0	22 0

Afterwards the declination increased till midday of the 19th.

Prof. Biendel states that this perturbation has also been observed on the temporary station of the Physical Association

of Francfurt, established on the mountain "Grosser Feldberg" (Taunus), but adds that any connection between the approach of Halley's Comet and the phenomenon must be provisionally held as doubtful.

FALMOUTH OBSERVATORY.—From the Meteorological and Magnetical Tables and Reports for 1909 just issued, it appears that the work of this important Observatory has been carried on without interruption throughout the year, and that continuous records have, as usual, been secured of pressure, temperature, wind, sunshine, rainfall and magnetism. The Meteorological instruments are the property of the Government Meteorological Committee, which contributes £250 a year towards the maintenance of the Observatory.

The Tables show that 1909 was a sunny year, the excess compared with the average being two hundred and four hours. There were only fifty-four days without sunshine, as compared with an average number of sixty-one such days. May was the sunniest month with two-hundred and thirty six hours (64% of the possible duration), and December the least sunny with fifty-five hours (23% of the possible duration). The temperature ranged from 77° in August to 28° in February, the mean being 50°·4. Frost was recorded in four months. The temperatures recorded in the Stevenson screen showed a greater range than those from the thermograph by 5° (80° in August to 26° in February.) The temperature of the sea taken about one mile outside Falmouth Harbour was taken regularly, and the mean for the year was 52°·1°, or 1°·0° below the average for twenty-nine years. The exceptional magnetic storm of September, 1909, was well observed, and the perturbations of both declination, horizontal force and vertical force were noted as passing off the paper in each case. The movements of the magnets were not only extensive but rapid. An interesting event of the year was the visit of the S.S. "Carnegie" to Falmouth in November. This ship has been specially equipped at the expense of the Carnegie Institution of Washington, U.S.A., for a magnetic survey of the Atlantic and Pacific Oceans, which it is expected will occupy fifteen years. Falmouth was chosen as the first port of call, because of the opportunity there afforded of comparing the standard instruments. The Tables given in the report are full, but it would be an advantage if the extremes for the year of the various elements were given in the yearly results, instead of the *means* of the monthly extremes, which have no value.

THE BRITISH RAINFALL ORGANIZATION.—The important announcement is made that the British Rainfall Organization has been formally transferred to Trustees, to be held by them for the nation.

This organization was founded by the late G. J. Symons, F.R.S., fifty years ago, and from very small beginnings it has grown to be the largest and most complete rainfall organization in the world. The first publication was a four-page pamphlet in February, 1861, giving the rainfall results at one hundred and sixty-eight stations for the year 1860. In the following year the stations had increased to five hundred and seven, and the Report occupied eighteen pages. Observers were added year by year, and by 1905 the number had reached four-thousand, and now they have almost reached five thousand. On the death of Mr. Symons in 1900, the data accumulated during forty years passed into the hands of Mr. H. Sowerby Wallis, who had been engaged in the work for twenty-eight years, and had been Assistant Editor of *British Rainfall* since 1890. In 1901 Dr. H. R. Mill joined Mr. Wallis in carrying on the organization, and when the latter was obliged to retire, on account of ill-health, in 1903, Dr. Mill purchased the leasehold of the historic rainfall house, 62, Camden Square, the instruments in use there and the whole collection of records accumulated up to date. Since 1903 Dr. Mill has had sole control, and the work has still further developed, and while it was always his intention to leave the records and the house as a bequest to the nation, Dr. Mill had come to feel that the transition from private to public ownership could be made with less risk of altering the character of the organization if the change were made under his own supervision, so that the continuity of the work would be fully preserved.

Accordingly, he requested nine representative rainfall observers to join him as Trustees, and on June 8th he formally transferred the whole of the property he had acquired in connection with the Rainfall Organization, as a gift to the new body, of which he became the Chairman, while continuing to act as Director as before. This is a gift to the nation of the utmost value and importance, and it is hoped that Dr. Mill's generosity and fine public spirit will be rewarded by seeing the work still more firmly established. It is the glory of British science that splendid results in all directions have been achieved by voluntary and unofficial effort. It is an added glory when voluntary workers like Dr. Mill are found ready to hand over for public purposes the results of half-a-century's expenditure of time and thought and money.

PHYSICS.

By W. D. EGGAR, M.A.

THE SUN'S MOTION WITH RESPECT TO THE AETHER.—The May number of the *Proceedings of the Physical Society* contains a paper by Dr. C. V. Burton dealing with the above subject. He proposes to make use of a method which had quite independently been foreshadowed by Clark Maxwell a good many years ago. Briefly it amounts to this. Regard the movement of the aether with respect to the Solar system as a wind with a constant direction in space. Then light from the planet Jupiter would reach us more quickly with the wind than against it. Just as observations of Jupiter's Satellites provided the first evidence of the velocity of light, so they may be looked to for evidence of the existence of this "wind." The subject becomes of more than usual interest in view of Kapteyn's discovery of the two main star-drifts, and also because the material for the necessary computations will soon be available through the Harvard photometric observations of the eclipses of Jupiter's Satellites. In view of the important part played by American observers in recent Astronomical advances, attention may be drawn to an article appearing in the *Quarterly Review* on the "Tercentenary of the Telescope." The writer of this article points out that some of the beautiful star photographs taken in America are less valuable than they might be owing to the incompleteness of the data accompanying them, and compares them unfavourably in this respect with those taken by Dr. Isaac Roberts, of Crowborough. It would be a pity if the beauty of the star-picture should be allowed to obscure its value as a scientific record.

EXPERIMENTAL BALL LIGHTNING.—A prevalence of the thunder weather such as has been experienced in June usually produces reports of natural phenomena unknown to scientific investigators; and the "thunderbolt" is one of the more common of these imaginary occurrences. For another phemonenon, known as "ball lightning," which popular tradition associates with thunderbolts, there is, however, more warrant, both in evidence and in experiment. Some experiments were made in 1905 by Professor Righi and afterwards repeated by Professor Trowbridge (*Astrophysical Journal*, May, 1907) which throw a light on these apparitions. Professor Righi discharged large volumes of positive electricity through a tube which was not quite a vacuum, but contained highly rarefied nitrogen. He found that instead of the steady luminous glow which appears in a vacuum tube, he was able to obtain slow-moving luminous effects, which travelled slowly from one end of the tube to another, in a direction depending on the increasing or diminishing intensity of the current. Professor Trowbridge adopted a different means for discharging sudden volumes of positive or negative electricity through the tube, making use of the method suggested by Sir Oliver Lodge in his electric valves. He obtained similar effects, and he believes that the slow movements of electrical discharges produced in this way are due to ionisation of the gas through which the electricity is passing. Ball lightning, similarly, may be due to a similar ionisation produced in the rarefied channels of air which are produced by the passage of ordinary lightning. This being admitted, there is nothing incredible in the reports of luminous "balls of fire" in a thunderstorm, travelling so slowly that they seem detached.

THE DEFINITION OF FORCE.—A rather acrid discussion is going on in the pages of *Science* (N.Y.) on the definition of Force, on which Professor Henry Crew commented in his Presidential Address to the American Physical Society. The question at issue is whether force should be regarded as a psychological concept, or whether it is sufficient to have a definition which will satisfy the standard engineer. Professor Crew, as reported in the last number of "KNOWLEDGE," believes that the one perfectly correct, competent and complete description of force is "the rate of change of momentum"; to which Professor William Kent rejoins that no doubt the idea of force is a metaphysical deduction from the formula FT=MV, but it is neither correct competent nor complete, and is not a definition at all. It assumes that we can translate the sign (=), which really means "numerically equal to" by the word "is." It is not even true as to equality, except under certain limited conditions —such as that the units have certain values (M=lbs÷g) and that the body is free to move. Therefore, Professor Kent returns to the following elaboration of his first definition of force:—A force should always mean the pull, pressure, rub, attraction (or repulsion) of one body upon another, and always implies the existence of a simultaneous equal and opposite force asserted by that other body upon the first body, *i.e.*— the *reaction*. In no case should we call anything a force unless we can conceive of it as capable of measurement by a spring balance, and are able to say from what body it comes.

STERILISATION BY ULTRA-VIOLET RAYS.—It does not seem very likely that the sterilization either of water or of milk by the application of ultra-violet rays will become a practical substitute for other less esoteric methods. Water in lakes and running streams, as well as in reservoirs, is daily subjected to the action of every kind of ray, and is not proof against the invasion of pathogenic bacteria in consequence. Evidently, therefore, some very specialised form of applying the rays to milk or water would be necessary in order to sterilise either. M. Gabriel Vallet, of Paris, who has been making experiments in this direction, has nevertheless arrived at some interesting results as to the penetrability of various substances by the ultra-violet rays. The source of light employed was a mercury vapour lamp: and the liquids were contaminated with an emulsion of *Bacillus coli*. The mortality among the bacilli when exposed to the ultra-violet rays at a distance of one inch from the lamp was taken as the measure of the absorption of the rays by the liquid. Some liquids such as ethylic alcohol, glycerine and many saline solutions were easily traversed by the rays; others, such as albumen, peptone and oil were strongly opaque. An artificial medium containing peptone, glucose, cream of tartar and water could not be sterilised under ordinary conditions, though each of the substances entering into its composition is quite far from the limit at which its solvent becomes opaque.

PHOTOGRAPHY BY INFRA RED RAYS.—Professor R. W. Wood, of John Hopkins University, recently proposed to photograph the Moon by ultra-violet and infra-red rays in order to determine, by comparison with the photographs of terrestrial objects obtained with these rays, some idea of the Moon's surface rocks. The investigation promises to be a tedious one even if it proves profitable, but possibly some by-products of investigation may emerge. He has constructed a screen or ray filter by combining a sheet of very dense cobalt glass with a deep orange aniline dye. This screen absorbed all rays below wave length six thousand nine hundred. The spectrum of the sun, or arc, photographed through this screen on a Cramer, or other spectrum-plate, is reduced to a band extending from $\lambda=6{,}900$ to $\lambda=7{,}400$. The rays within this region are visible to the eye, if all other rays are excluded, but they play no part in ordinary vision, on account of their very feeble action upon the retina. Landscapes photographed with Professor Wood's screen present a remarkable appearance. The grass and trees are snow white; the sky is black. This is because the chlorophyll of tree-leaves reflects the infra-red powerfully, while the blue sky absorbs it.

ZOOLOGY.

BY PROFESSOR J. ARTHUR THOMSON, M.A.

COLLECTING AT CAPE ROYDS.—One lays down the first instalment of the biological results of Sir Ernest Shackleton's Antarctic expedition with a warm admiration for the collectors who waited at Cape Royds (77° 32′ S) and made the most of a very unpromising locality. On the shore, there was no vestige of life; nothing but funereal black sand when the foot-ice was gone. In shore, the black lava showed no vegetation higher than mosses, and very little of them. The lichenous "*tripe de roche*," "familiar in books of Arctic travel for its rôle in prolonging the life of starving explorers" was "scarcely so abundant as to fulfil the same life-saving rôle in the Antarctic." Ice covered the sea; ice—fifteen feet of it—covered the little lakes. But Mr. James Murray, and the others under his guidance, lost no time in regretting the absence of faunistic amenities. They hauled a dredge from hole to hole below the sea-ice, and got sponges, sea-anemones, alcyonarians, starfishes, crustaceans, and molluscs. They made holes, which the Weddell seals helped to keep open, and baited traps, yielding molluscs, crustaceans, and worms. They cut down through fifteen or more feet of ice in the inland lakes, singing songs to keep themselves cheery, and thus reached the floor of foliaceous vegetation,—and a rich micro-fauna and micro-flora. There were abundant Rotifers, especially of two viviparous new species, able to withstand all sorts of oscillations of temperature; there were water-bears, and mites, and two species of Entomostraca, besides Nematodes, Infusorians, and two kinds of Rhizopods. Many thoughts are suggested by Mr. Murray's reports, but the most dominant is that of the persistent character of life—spreading everywhere, insinuating itself, adapting itself; resisting everything, defying everything, surviving everything.

POISON SPINES OF THE HEART-URCHIN.—On the dorsal surface of the yellow heart-urchin, *Echinocardium flavescens*, there are little "gemmiform pedicellariae," that is to say, peculiarly modified snapping spines. It was shown some time ago by Prouho and by von Uexküll that these give poisonous bites, but some interesting details have been recently published by Gandolfi Hornyold. He put a small Annelid on the back of the heart-urchin and watched the spines snap at it. A reddish fluid flowed out from their tips and the worm was dead after a few minutes of violent wriggling. The minute pedicellariae then separated themselves off from the test and remained imbedded in the worm. They all broke at the same place, just at the joint between base and test, and some of them were re-grown in about a month. It may be recalled that the common sea-urchin has also the power of re-growing its spines.

POISON GLANDS OF CUTTLEFISHES.—Several investigators have shown that the extract of the so-called salivary glands of cuttlefishes, such as the common *Eledone moschata*, has a rapid paralysing action on the central nervous system of crabs. Etienne de Rouville has verified this, and finds that the poisonous effect is by no means restricted to crabs, though of course very useful in this connection, since crabs form an important part of the food of cuttlefishes. He shows that the extract (of the posterior pair in particular) is markedly toxic when injected into rabbits.

THE WEB OF LIFE.—Everyone knows how the introduction of the mongoose into Jamaica affected the rats and the birds, and the insects that the birds used to eat. Mr. Thomas Barbour has been following this up recently in regard to the reptiles. "The introduction of the mongoose (*Herpestes griseus* E. Geoff.) has caused the almost complete extinction of many species which were once abundant, and has in some ways radically changed the facies of the fauna. In the back country, lizards are rarely met with, and it is only in the vicinities of villages and towns, where they are more or less protected, that one may obtain satisfactory series of many species. The true ground-inhabiting forms have, of course, suffered most, so that lizards of the genera *Ameiva*, *Mabuia*, and *Celestus* are now scarce and difficult to obtain. Snakes have suffered perhaps more than lizards."

XUM

MICROSCOPY.

As Microscopy is the hand-maiden to very many branches of Science, it is difficult for one worker to deal with the whole subject, and a suggestion has been followed that a number of those who use the microscope in their studies should be responsible for the microscopical column in KNOWLEDGE. We have pleasure in announcing that the well-known microscopists whose names are given at its head have already promised to help.

ARTHUR C. BANFIELD.
JAMES C. BURTON.
THE REV. E. W. BOWELL, M.A.
CHARLES H. CAFFYN.
ARTHUR EARLAND.
RICHARD T. LEWIS, F.R.M.S.
CHARLES F. ROUSSELET, F.R.M.S.
D. J. SCOURFIELD, F.R.M.S.
C. D. SOAR, F.R.M.S.

A USEFUL MICROSCOPE ACCESSORY.—When it is necessary to use on the microscope an objective of long focus, say three or four inches, it is often found that the instrument will not rack up far enough. This is the case with many microscopes, and the usual method of getting over the difficulty is by having an objective thread at the bottom of the draw tube. This is all right in some cases, but its disadvantage lies in the fact that the operator is tied down to the draw tube length—often a matter of only five inches. The photograph shows an arrangement in which all the drawbacks are overcome at a small cost. A small stage about two-and-a-half inches square is cut out of thick black vulcanite, one-eighth of an inch and two thin clips attached to it. This must have an aperture one-and-a-half inches diameter. It is then fitted on the top of the sub-stage. If a slide is now put on this miniature stage, another two inches of space between the objective and object is secured. The condenser cannot be used at the same time, but seldom or never is this required with three or four-inch objectives, the mirror alone supplying sufficient light. The small stage under the ordinary stage is shown in the illustration below.

R. BORROW.

A device in the form of a small stage placed on the top of the sub-stage for use with objectives of long focus in cases where the microscope will not rack up sufficiently high to allow of the ordinary stage being used.

DARK GROUND ILLUMINATION WITH HIGH POWERS.—The ability to see living bacteria without the tedious process of preparation and staining, by the use of one of the many dark ground illuminators that are now obtainable, has to a large extent revived interest in microscopy amongst those who deal with such subjects.

It is not generally known, however, that a similar effect can be obtained by the means usually at the disposal of the average microscopist. The Rev. R. F. Jones has devised a plan, whereby the ordinary Abbe Illuminator, if suitably arranged, will do all that is required. There are certain essentials however, and the first of these is that there must be some centreing and focussing arrangements for the Condenser. This remark holds good with regard to the new dark ground illuminators, and, in fact, the necessity is becoming intensively obvious with the advance of microscopical technique. The time will come when every worker will recognise that a centreing arrangement to his Condenser is of vital importance.

The first necessity for the Condenser then is that a centreing arrangement must be provided, for the success or failure of the whole attempt is dependent upon accurate centreing.

A black patch stop will be used beneath the Condenser Lenses, and this again must be properly centred. The best way to ensure this is to have a number of discs cut in metal or black paper and fix them to glass discs cut to the size of the stop carrier of the Condenser.

The black patch is moved until it is in the right position, and then allowed to dry. The size of the black patch can be ascertained by experiment. It will vary in each case with the numerical aperture of the objective and the Condenser.

The detail in bacteria is not such as calls for a large numerical aperture in the objective, and the high magnification that is necessary to disclose the contour can be used, while the numerical aperture of the objective can be reduced by a diaphragm at the back. This is the rule that should be followed when using the Abbe Illuminator as here described.

It is necessary to use, as nearly as possible, a spot of light as the source of illumination. An incandescent gas lamp with a diaphragm in front is probably the best.

To test the centreing of the whole system, the aërial image of the dark patch stop should be focussed when the Condenser is in position, and as the Condenser is moved downwards out of focus the spot should gradually become reduced in size, maintaining its centre if set axially.

MICROSCOPY AT THE JAPAN-BRITISH EXHIBITION.—Microscopy is not largely represented this year at Shepherd's Bush, either in the Japanese or British portions of the Exhibition. In the Japanese section four microscopes of native manufacture are exhibited by Tanaka & Co., of Tokyo. Of these, one is intended for dissecting purposes, being fitted with a simple lens and hand rests on either side of the stage; it is mounted on a solid horse-shoe foot, and appears to be well adapted for the purpose. Two others are compound instruments with short bodies not made to incline, and focussing with a sliding tube.

The fourth is of similar construction, but is plated and provided with a back handle by which the microscope can be easily carried in an upright position. Objectives of different powers for use with the compound microscopes are also shown. In the lower part of the same case-section, cutting machines bearing the name of S. Goto, Tokyo, are also exhibited, together with the blades for use therewith; a variety of dissecting knives and other instruments are to be seen in the same glass case.

In the British Science Section the only microscope to be seen is one included amongst apparatus for the study of crystals, but there are exhibits by The Liverpool School of Tropical Medicine and the London School of Tropical Medicine, which comprise numerous specimens of blood parasites, for the discovery of which the microscope is essentially necessary. Here we have examples of those producing malaria, ague, and yellow fever, introduced into the human system by several species of mosquito, the Trypanosomes of Sleeping Sickness, communicated by *Glossinia palpalis*, a species of Tetse fly, and those of Bubonic Plague, together with the fleas which are said to be the active agents in communicating the infection from three species of rats.

In the British Photographic section some excellent photo-micrographs are exhibited, amongst which may be noted a section of human retina × 200, *Arachnoidiscus Ehrenbergii* × 1800, Trypanosomes and insects capable of transmitting disease, by Mr. F. Martin Duncan, *Amphipleura pellucida* × 1,000 and × 4,000, and the remarkable enlargement of the same diatom to × 10,000 by Dr. E. J. Spitta.

RICHARD T. LEWIS.

NOTES ON THE BRITISH FORAMINIFERA.—1. THE COLLECTION OF LIVING SPECIMENS. No objects are more admired at microscopical exhibitions and few are more frequently shown than the beautiful shells of the Foraminifera. Yet how few people, apart from students of the group, have ever seen a living specimen. During an experience of microscopical soirées and exhibits extending over a quarter of a century, the writers could certainly count the number of occasions on which he has seen a living exhibit of this group, on the fingers of one hand. And after all the dead shells cannot compare in beauty and interest with living specimens well displayed, and as living Foraminifera are easy to obtain, and no harder to preserve alive than other microzoa, the only reason for their rare appearance at soirées must be the ignorance of exhibitors as to the methods of collection and preservation.

Just now, when many microscopists are trooping to the seaside for their annual holiday, seems a favourable time for the publication of the writers' experience on the subject, based on more than twenty years collecting. The apparatus required is of the simplest description: a pail, a coarse sieve with meshes one-eighth inch in diameter, and a jar or tank in which to preserve the specimens when caught. The horsehair sieves used by cooks are best as they do not corrode, but a metal sieve will do if it is carefully washed and dried after use. The writers use an enamelled pail with a diaphragm of galvanised iron wire net. If preferred a second sieve of fine bolting silk may be substituted for the pail, and this is the method recommended and used by Mr. J. J. Lister, but the writers use a pail for the collecting, as it retains the diatoms and other microscopic organisms on which Foraminifera feed, the bulk of which pass readily through the meshes of a silk sieve.

Foraminifera are to be found in abundance in the shore sands of nearly every coast, but the shells obtained by scraping the white patches between tide marks in the manner described by one of the present writers in a former issue of "KNOWLEDGE,"* are almost all dead and empty specimens, deposited on the beach by the elutriating action of the tides. To obtain living specimens in any numbers without the use of a dredge we must have recourse to a shore on which rock pools or weed-grown patches can be found between tide marks, although a certain abundance can be obtained on any muddy foreshore. The pail should be half filled with sea water and the sieve rested in it so that the upper rim is not submerged. A handful of small weed, coralline or confervoid preferably, is then torn off, placed in the sieve and thoroughly rinsed with an up and down motion of the sieve in the water. All the small organisms, Foraminifera, Copepoda and so on, and most of the fine mud and diatoms adherent to the weed will pass through the meshes into the pail. The process is repeated until a sufficient quantity of débris has accumulated in the pail.

For the preservation for observation, of the living Foraminifera, a suitable tank or aquarium must be prepared. The small aquaria sold by most opticians dealing in microscopical accessories, answer admirably, as they are easily transported and allow the living organisms to be watched through the sides either with a strong pocket lens or a proper tank microscope. They consist of two pieces of clear flat glass, about 6-in. by 8-in., set in a metal frame about one inch apart. The frame is secured to a wooden base to give additional stability. The bottom of the tank must be covered with pebbles or small fragments of rock, on which green seaweed *Ulva* or *Cladophora* is in active growth. The tank is then three-parts filled with sea water and the muddy débris poured in, the surplus water being first syphoned out of the pail after the mud has settled. The mud will settle down in the aquarium and fill up the interstices between the stones. The object of the weed is to oxygenate the sea water, a method far preferable to the syringing usually recommended, as it can be regulated by the amount of light which is allowed to reach the tank. Moreover, when the weed is in active growth it supplies the Foraminifera with food in the shape of motile zoöspores.

Before the muddy débris is placed in the aquarium it is well to empty it into a shallow dish, and remove any undesirable objects, such as worms, large crustacea, or large fragments of weed, which may have been washed out of the sieve. These would otherwise rot, and set up putrefaction in the water before the aquarium is properly in going order. Once the tank is well started, Nature can generally be trusted to keep the balance of life and death pretty equal, for the presence of a certain proportion of monads and infusoria in the water, due to and living on the decay of organisms which have died, seems to be beneficial rather than otherwise to the Foraminifera, serving them as food. If these microzoa appear to increase too rapidly, which can be seen with the microscope, or tested by the sense of smell, they can be checked or stopped by increasing the oxygenation of the tank, which is effected by exposing it for a short time to the direct influence of sunlight.

The natural evaporation from the surface of the aquarium would rapidly render the water too saline for life, and this must be remedied by the addition of the necessary quantity of fresh water as required. The easiest method of preserving the water at its correct salinity is to place a pair of glass specific gravity bulbs in the tank. These can be obtained at a very moderate cost from the dealers in chemical apparatus. They are obtainable in pairs, clear glass and blue glass. The blue bulb sinks to the bottom in normal sea water, gradually rising as the salinity increases owing to evaporation. The clear glass bulb floats in normal sea water and sinks if the specific gravity is reduced by the introduction of too much fresh water. The bulbs require a certain amount of care in their use, as the attachment of any organism to the clear bulb will cause it to sink to the bottom, while the blue bulb often rises under the buoyancy of a bubble of oxygen derived from the weed. It is well therefore to examine the bulbs before adding fresh water at random, and the latter must be introduced a few drops at a time and left for some minutes to mix with that in the tank.

When the muddy débris is added to the tank, for many hours, or sometimes days afterwards, few, if any, signs of Foraminifera will be seen. They are all buried under the thin semi-liquid mud. But they will gradually emerge and make their way towards the glass, up which they slowly crawl by means of their pseudopodia, which can be seen surrounding them in an opalescent halo if the tank be examined by oblique light. In the course of a few days the glass sides will be seen to be thickly studded with the tiny shells, prominent among which, owing to its comparatively large size and great

* See "KNOWLEDGE" for January, 1902, pp. 19-21, and February, 1902, pp. 44-45.

XUM

abundance, will be the handsome Miliolid, *Massilina secans* d'Orbigny. Any especially interesting species may be removed by means of a pipette to the smallest sized tank procurable so as to be readily available for examination. The fused glass tanks sold by the opticians are especially adapted for this.

For the purpose of examination there is nothing finer than the Greenhow-Smith model of tank microscope, made by Zeiss, for those who can afford the luxury of such an instrument. With it specimens can be examined in the tank under a comparatively high power. But the strong light of a Nernst lamp is required to do justice to it, although with the lower powers good results can be obtained with an ordinary microscope lamp and bullseye condenser. The best results are obtainable with direct light, as the thickness of the tank militates against the use of transmitted light.

For those who have to rely upon the ordinary microscope and for any work with high powers, the living "foram" must be removed to a cell or excavated slip. After the specimen has been located on the glass side of the aquarium it must be detached with a needle or fine brush with one hand, and as it falls down the side of the tank must be caught with a pipette held in the other. Foraminifera are very sensitive to vibration or shock, and draw in their pseudopodia rapidly, but in most instances they will quickly recover when placed on the stage of the microscope, and again protrude them. The first sight of a fine *Polystomella* or *Massilina* with its pseudopodia fully extended is indeed an experience never to be forgotten.

EDWARD HERON ALLEN, F.L.S.
ARTHUR EARLAND.

REVIEWS OF BOOKS.

BIOGRAPHY.

The Life of Lord Kelvin.—By SILVANUS P. THOMPSON, F.R.S., in two volumes. 10-in.×6-in. 1297+xx pages.

(Macmillan & Co., Ltd. 30/- net.)

It would have surprised no one if we had had to wait ten years for the biography of a genius so varied as Lord Kelvin; and, if merely on account of its expedition, the life which Professor Silvanus Thompson has written of him, is a remarkable achievement. But it has far more solid claims to recognition. Not only does it bear witness to the many-sided activity of the great man whom it commemorates; not only is it a compendious reference and index to his work, its implications and its influence; but it is also a satisfying portrait of William Thomson. As artists say of a portrait, it fills the eye. The success of the biographer from this point of view is no less remarkable because he, like nearly all who came within the radius of Lord Kelvin's influence, is inspired by an affectionate admiration, amounting almost to worship, for his subject. It was a feeling which, as Professor Silvanus Thompson observes, spread far beyond the intimate personal friends, to the disciples. He might have added that it reached to the lay auditors of Lord Kelvin's "*Popular Lectures and Addresses*": and was stimulated even by the sight of the great man at a British Association meeting, expounding abstruse theories with a piece of chalk at the blackboard. The means by which the biographer has achieved his end of personal portraiture are apparently simple. He has not been content with a personal view; but has shown by a happy selection of letters and appreciations the impression that Lord Kelvin created in his contemporaries throughout his career—from the time he was an undergraduate with an incipient taste for the French horn, till the date of his Presidency of the Royal Society. The impressions are reinforced by many of Kelvin's own letters. Often enough a man's own letters reveal him but little, because few people have the gift of literary self-expression; but in Kelvin's case the revelation, such as it was, merely emphasises the almost child-like sincerity and simplicity which throughout his life he retained.

In their scientific aspect these volumes are of the highest value. They are supplemented with appendices, one of which, of seven pages, affords a perspective view of the influence Lord Kelvin had on the scientific thought of his time, by enumerating his academic distinctions and the scientific and learned societies to which he belonged; and the second of which, of fifty-four closely printed pages, gives the names of and references to his contributions to scientific literature. The extent and varied character of the items in this list are almost incredible; and they deepen the sense of the magnitude of the task which Professor Silvanus Thompson undertook in summarising the life-work of so indefatigable a worker. All that can possibly be done with such a mass of material is to describe the main tendencies of the investigations, and to indicate in its broader aspect the influence and value of Lord Kelvin's contributions to the various branches of science. With this limitation the list is hardly any the less impressive. There is a story told of Lord Kelvin's visit to Peterhouse, at Cambridge, when the college held its Quincentenary. As the result of a little plot among the undergraduates, a number of them, when presented to Peterhouse's illustrious son, gravely congratulated him on his famous invention of a beer tap. Lord Kelvin presently quite entered into the spirit of the joke, which was really a very high compliment to his ability, as well as to his character; for it recognised that combination of theory and practice which had enabled him to lay firmly the foundation stones of thermo-dynamics, and make possible an Atlantic cable; and which, besides making imperishable contributions to mathematical and electrical physics, could achieve the work-a-day results of a siphon recorder, a mariner's compass, and a tide-predicting machine. The biography of Lord Kelvin is written in a hundred scientific memoirs; but a better, a more complete, or a more scientific guide to the mass of material cannot be written than that which we owe to Professor Thompson.

BIOLOGY.

The Mutation Theory.—By HUGO DE VRIES. Translated by Prof. J. B. FARMER and A. D. DARBISHIRE. Vol. I. 582+xvi. pages. 10-in.×7-in.

(Kegan Paul, Trench, Trubner & Co., Ltd. 18/- net.)

It is of the greatest importance, as well as a source of great satisfaction, to English students of Heredity, to have at last a translation of Professor Hugo de Vries, "*Die Mutations Theorie*," and Professor Farmer and Mr. Darbishire are to be congratulated on the discernment and sympathy, no less than on the accuracy, with which their work has been done.

In its translated form this work will enable a better estimate to be made, not merely of what De Vries has done, and what he has claimed for his theory of Mutations, but also of what he has not claimed, and of what he has not attempted. It is clear to anyone who read his contribution to the volume on "*Darwin v. Modern Science*," (Cambridge University Press, 1909,) that his aim was not the criticism of the Darwinian theory of Natural Selection, nor even the diminution of its validity or of the effectiveness of the natural causes which it examined. The attitude of De Vries, like that of many modern zoölogists and the majority of modern botanists, is that Darwin's theory of Natural Selection seeks to explain the elimination of the unfit and the persistence of adaptations rather than the origin of adaptations. De Vries has even argued that Darwin himself was conscious of this limitation of his theory, and recognised that some variations which "happened to arise" were different from the ordinary fluctuations which arise from time to time (Cf. "*Darwin and Modern Science*," p. 71). That may

not be the case. Indeed, those who knew Darwin best deny that he thought so. But to mention it is to emphasise what De Vries really has sought to explain,—"The special problem which the mutation theory seeks to explain is the manifold diversity of specific forms," (p. 45). It seeks to account for the origin of specific characters. Or again, to quote De Vries himself (p. 165), we may express the essence of the mutation theory in these words—"Species have arisen after the manner of so-called spontaneous variations." That expresses the basic difference of the two creeds. If a handful of peas be chosen, then, in spite of their apparent similarity, there will be minute differences between them. Darwin did not trouble about the origin of these extremely minute differences. He supposed merely that if by the conjugation of minute differences, a minute difference happened to survive, and happened also to be environmentally suited, it would thrive and continue. De Vries does trouble about these minute differences. He distinguishes between them. There are some differences which are mere fluctuating variations. There are others which may appear (to any ordinary method of estimation) equally small or even smaller, but which are of elementary importance. These are the mutations; and many mutations are smaller than the difference between extreme examples of fluctuating variations; but they *are* mutations. They are important. They tend to persist, and they tend to persist without any help from outside. They arise without any reference to environment. They may even be superior to environment. The mutation occupies in biology the same position that the elemental change occupies in the theory of the atom. The point at issue is whether the "mutation" is a reality, or whether it is a mere figment to explain the beginnings of a species. In fact, one of the chief objects of this book, both in its original form and in its translation, is that of making clear the fundamental difference between a fluctuation, or a fluctuating variation, and a mutation or a change which may appear suddenly, and is of prime importance, first in regard to its persistence, and consequently in its permanent influence on the future history of a species. This English translation has had the advantage of careful revision and correction by Professor De Vries, and is of the greatest value, interest and importance. The second volume will be eagerly awaited.

Science in Modern Life, Vol. V.—*Agriculture*, by JAMES WILSON, M.A., B.Sc. *Philosophical Biology*, by J. BEARD, D.Sc. *Physiology and Medicine*, by B. MOORE, M.A., D.Sc. *Antrohpology*, by H. SPENCER HARRISON, D.Sc. 10-in.×7-in. 207 pages, with many illustrations.

(Gresham Publishing Company, Ltd. 6/-.)

In the penultimate volume of the Concise Encyclopaedia of Scientific Papers which is edited by Mr. Ainsworth Davis under the title of "*Science in Modern Life*," the summaries of the present state of knowledge in Agriculture, Philosophical Biology, Physiology and Medicine, and Anthropology, follow on those on more generalised branches of science which have appeared in previous volumes. The difficulties of thus summarising for general consumption the chief principles, and the most recent propositions of any science, however, specialised its scope, are evident on the face of things; and the highest compliment we can pay to the compilations before us is that the difficulties are less apparent than real. The results cannot be satisfactory in every case. A section on Agriculture, for example, which devotes eleven pages to the history of the topic, five to modern agricultural machinery, and dismisses the rest of the subject in some seven pages which ignore the vast subjects of the scientific improvement of wheat and butter, can only be regarded as sketchy. If, as is probably the case, these volumes pass into rural libraries, such a treatment of what is still the chief industry of the country will probably be regarded with a feeling akin to indignation. The summary treatment of agriculture, however, should not, and will not, blind any intelligent reader to the brilliant essays in compression which are due to Dr. Beard and Dr. Benjamin Moore. Dr. Beard's article on Philosophical Biology presents in a remarkably clear and concise way the Mendelian theories, the views of De Vries, and the relations of these views to those of the biometricians. He places these, together with Hering's hypothesis of Unconscious Memory as the basis of Heredity, in their proper perspective in evolutionary theory, and his article as a whole is a truly valuable survey of the subject. Dr. Benjamin Moore has a more diversified task in describing the present state of knowledge in physiology and medicine; and in more than one instance—as in the consideration of fatigue toxins, or in that of immunity in infective diseases, the necessity for saying what he has to say as shortly as possible, leads him into statements which he would be the last to pretend are universally accepted. But in a rather thankless task he has done extremely well; and though he has sown in haste, the reader will not reap in indigestion.

Nature Study on the Blackboard.—By W. P. PYCRAFT and JANET HARVEY KELMAN. 9¼-in.×11¾-in., 138 pages, 34 plates.

(The Caxton Publishing Company. Price 22/6 net, 3 vols).

Volume I. deals with plant-life, and is a successful attempt to assist those teachers—of whom unfortunately there are many—who are not adept at rapid sketching as an accompaniment to a lesson. In the preface it is stated at the outset that "the vital necessity of bringing the learners into immediate touch with natural objects has been kept consistently in view." If teachers will bear this in mind, and use the sketches only as a means of expressing what has first been discovered from a careful examination of the actual specimens, the book should prove a valuable addition to the school library.

PHOTOGRAPHY.

The Telegraphic Transmission of Photographs.—By T. THORNE BAKER, F.C.S., F.R.P.S., A.I.E.E. 5¼-in.×7½-in. 146 pages. 64 illustrations.

(Constable & Co., Ltd. Price 2/6 net.)

All who are interested in illustrated newspapers know that the telegraphic transmission of photographs is now a practical method of getting pictures from a distance in less time than they could be conveyed by hand. Indeed the gain is just the difference between a letter and a telegram. It is due largely to the work of Mr. Thorne Baker himself that this is possible, and in the last chapter of this volume he shows some successful preliminary experiments in the transmission by "wireless" installations. The author describes and illustrates the early attempts as well as the most recent successes, and writes generally for the non-technical reader, so that he may know "how it is done." At the same time the book is more than a mere popular treatise, and will prove of interest to the scientific student.

Modern Telephotography.—By CAPTAIN OWEN WHEELER, F.R.P.S., 5¾-in. × 8¼-in. 95 pages. Illustrated.

(Ross, Ltd. Price 1/6 paper covers, bevelled boards 2/6.)

Captain Owen Wheeler has laid under an obligation all those who use telephotographic lenses, by the publication of his experiences in a handy volume. He deals with the subject in a thoroughly practical way, regarding every detail from the standpoint of the individual who wants to get photographs of generally distant but sometimes near objects on a larger scale than the more usual photographic objectives render them. The illustrations show that he is a most successful worker, getting magnifications up to even about forty diameters. This last means that an object that gives an image only the one-tenth of an inch long when using an ordinary lens, will give an image that covers the quarter plate. The author concludes with a chapter on telephotography in its applications to the special requirements of the Army and Navy.

XUM

Engineering Workshop Machines and Processes.—By DIP-ING F. ZUR NEDDEN, translated and revised by JOHN A. DAVENPORT, M.Sc., 5¾-in. by 8¾-in. 216 pages. Illustrated.

(Constable & Company. Price 6/- net.)

When a young man from college enters on his real business training, he finds himself among practical men, many of whom have, or profess to have, a contempt for academic training, and are naturally prone to laugh at his ignorance of the A B C of their craft. He is ashamed to be always asking questions, and yet there are many things that he wants to know, and feels that he ought to know. In no profession is this need more felt than by the young engineering student when he enters the shop. In no profession is practical knowledge more indispensable. The young man must find some things out for himself, and if he cannot understand all the technical slang he must not be shy of asking its meaning. But a book of this kind will not only save him many embarrassing questions, but it will put many ideas into his head, and suggest subjects for discussion with workmen. To quote from the introduction by Sir Alexander Kennedy "Its intention is to set out in a condensed but intelligible form those matters which a young engineer entering shops for the first time will find frequently to be taken as data—assumed as being known already by those who are around him in the shops, to whom all such matters are so familiar that they seem hardly worth while telling." The book may be confidently recommended to any budding engineer. The English translation omits some features of the original which are only applicable to German students; while it adds, as an appendix, the report of the Committee appointed by the Institution of Civil Engineers on the Education and Training of Engineers. This Report should be read by parents.

Problems in Time and Space.—By F. A. BLACK, F.R.S.E. 5½-in. × 8½in. 362+xx pages.

(Gall and Inglis. 6/- net.)

This is a collection of essays, more or less connected, on astronomical and geographical subjects. They may be recommended without reserve to any reader for whom arithmetic and simple geometry are not deterrent; and the student of mathematics who wishes to obtain a clear notion of the foundations of astronomical and geographical measurements will find in these essays very clear expositions of such problems as the determination of the distance and size of the sun, the figure and dimensions of the earth, the length of the year, the movement of the sun in space, magnetic charts, and other kindred matters. There is an inborn tendency in most human beings to take statements on trust; it saves trouble, and it may afford students of human nature some satisfaction to think that in many cases the confidence is not misplaced. But there is also a tendency, manifesting itself in the cheaper press, to take advantage of the readiness of the public to swallow anything presented in the form of a scientific fact. It is therefore that a welcome is due to books of the stamp now before us, which, in addition to telling us that the mean distance of the sun is 92,897,000 miles, a fact which we are all too prone to accept without question, explains with admirable clearness how such figures have been arrived at in the past. Among other interesting features of the book there is an account of the inventor of logarithms, who by-the-way lived before the days of e, the base of the so-called Napierian logarithms. Another essay puts forward an ingenious suggestion for the reform of the calendar, which would make each year consist of an exact number of weeks. The historical treatment of the various subjects discussed adds to the value of an interesting book.

GEOLOGY.

Geology.—By J. W. GREGORY, F.R.S., 4½-in. × 6½-in., 140 pages; 10 figures.

(J. M. Dent & Sons, Ltd. Price 1/- net.)

This is an addition to Dent's excellent little series of Scientific Primers. As the author explains in the preface, some important geological principles, usually omitted in this class of work, are treated in as simple language and as short a space as possible. For instance, more attention has been paid to the materials of the earth than to the geographical processes affecting them, on the ground that although the latter is the more picturesque and popular branch of the science, the study of the constituents of the crust is the essential basis of geology.

Some idea of the scope of the book may be obtained from the titles of the four parts into which it is divided; I. The Early History of the Earth; II. The Materials of which the Earth is made; III. Physical Geology; IV. Historical Geology. A glossary and full index is provided. The book is free from misprints, and the only slip we have been able to find is the substitution of "aqueous" for "igneous" in the first item of the glossary (page 133). A clear, simple, and attractive style is adopted throughout. A beginner, desirous of making a first acquaintance with geology, could not do better than to read this book.

QUERIES.

1. At what time of the year should the fungus (*Asterosporium hoffmani*), found on the bark of beech trees, be looked for?

ATOM.

2. Without instruments, books, or knowledge of the compass bearings, how can time be found approximately at night?

F.R.A.S.

NOTICES.

A NEW CATALOGUE.

The 1910 catalogue of Microscopes and Accessories issued by Messrs. James Swift and Sons consists of nearly one hundred pages. It contains a collotype plate of photo-micrographs, taken with the acromatic objective made by the firm, which are an excellent testimonial to the latter. A special feature is made of petrological and metallurgical microscopes, while the dissecting stands provided to binocular microscopes, the apparatus for maintaining a circulation of hot water on the stage of the microscope, and the scissors which clasp a specimen after it has been cut off instead of letting it fall away, are among the accessories which will be found most useful.

THE ROTHAMSTED EXPERIMENTS.

A meeting of the Society for Extending the Rothamsted Experiments was held at Rothamsted on June 16th, under the presidency of the Duke of Devonshire. The Society has been incorporated with the object of obtaining additional funds for the development of the agricultural investigations which have been carried on so long under the late Sir John Lawes and the Lawes Agricultural Trust, which he afterwards founded.

The immediate object of the Society is to obtain a sum of £5,000 in order to secure about two hundred acres of land adjoining the present experimental fields, and erect thereon the buildings required for feeding experiments with the crops under investigation.

An appeal for subscriptions towards thus securing a small self-contained farm for the Rothamsted Experimental Station is now being circulated, and at the meeting of the Society on Thursday, a first list of donations was reported from the Duke of Devonshire, Lord Iveagh, Sir J. T. Brunner, Colonel E. H. Carlile, M.P., Mr. J. F. Mason, M.P., and Mr. J. Martin White, amounting to £1,450.

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